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Configuring Differentiated Services

NORTEL NETWORKS™

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Contents

Preface

Before You Begin xv
Text Conventions xvi
Acronyms xviii
Hard-Copy Technical Manuals xix
How to Get Help xix

Chapter 1
Differentiated Services Overview

Implementing Differentiated Services 1-1
Components of a Differentiated Services Network 1-2
Communicating with the OPS Policy Server 1-4
Marking Packets for Specific Services 1-5
URL Filters 1-8
Queue Management and Scheduling (QMS) 1-9
Queue Management Using WRED 1-9
Queue Scheduling Using DRR 1-10

Chapter 2
Starting Differentiated Services

Planning for a Differentiated Services Network 2-2
Starting Configuration Tools 2-2
Preparing a Configuration File 2-2
Starting Differentiated Services Using the BCC 2-3
Enabling Differentiated Services 2-3
Choosing a Filter Mechanism 2-4
Enabling COPS 2-4
Starting Differentiated Services Using Site Manager 2-5
Enabling Differentiated Services 2-5
Choosing a Filter Mechanism 2-5

Enabling COPS 2-6
Configuring Queue Management and Scheduling 2-7
How DSQMS Elements Work Together 2-7
Implementation Notes 2-9
DSQMS Configuration Steps 2-10
Enabling the RED Algorithm 2-10
Configuring an Instance of dsqms-red 2-10
Configuring DSQMS on an Interface 2-11
Enabling DSQMS on an Interface 2-11
Adding a DSQMS Queue to an Interface 2-12
Adding a Traffic Classifier to a Queue 2-12
Where to Go Next 2-13

Chapter 3
Configuring Static Traffic Filters for Differentiated Services

DiffServ Traffic Filter Concepts and Terminology 3-1
Traffic Filter Templates 3-2
Traffic Filters 3-2
Filter Precedence 3-3
Filter Criteria 3-4
Filter Actions 3-4
Creating Static Filters Using the BCC 3-5
Specifying Match Criteria 3-6
Specifying Source and Destination Networks As Match Criteria 3-6
Specifying Source and Destination TCP and UDP Ports As Match Criteria 3-7
Specifying Protocol Identifiers As Match Criteria 3-9
Specifying the DS Field As a Match Criterion 3-10
Specifying URLs As Match Criteria 3-11
Specifying TCP-Established Match Criteria 3-11
Specifying User-Defined Match Criteria 3-12
Specifying the Action of Traffic Filters 3-13
Specifying Police Parameters 3-14
Specifying the Log Action 3-15
Disabling and Reenabling Traffic Filters 3-16
Configuration Example 3-16

Creating Static Filters Using Site Manager 3-17
Creating a Filter Template 3-17
Applying the Template to a Filter 3-19
Configuring Filters for HTTP Packets 3-20
Customizing the Action of Traffic Filters 3-21
Modifying URL Match Criteria 3-22
Where to Go Next 3-22

Chapter 4
Customizing Differentiated Services

Modifying a Differentiated Services Interface 4-2
Disabling and Reenabling Differentiated Services 4-4
Deleting a Differentiated Services Interface 4-6

Chapter 5
Customizing COPS

Modifying COPS Global Parameters 5-2
Adding COPS Servers 5-3
Prioritizing COPS Servers 5-4
Modifying the COPS Connection 5-5
Maintaining the TCP Connection to the Server 5-7
Changing the Remote TCP Port 5-9
Disabling and Reenabling a COPS Server 5-10
Deleting a COPS Server 5-11
Disabling and Reenabling COPS on the Router 5-12
Deleting COPS from the Router 5-13

Chapter 6
Customizing Queue Management and Scheduling

Modifying RED Parameters 6-2
Activating DSQMS Configuration Changes on an Interface 6-3
Configuring DSQMS to Dequeue Packets at Line Rate 6-3
Modifying the DSQMS Debug Level on an Interface 6-4
Modifying a DSQMS Queue 6-5
Changing a DSQMS Classifier's RED Function 6-8
Disabling DSQMS on an Interface 6-8

Disabling a Single DSQMS Queue 6-9
Deleting Unused dsqms-red Entries 6-9

Appendix A
Site Manager Parameters

Interface List Parameters A-2
Interface Record Parameter A-5
Differentiated Services Global Parameter A-6
COPS Global Parameters A-7
COPS Server List Parameters A-9
COPS Server Record Parameters A-15
Static Traffic Filter Parameters A-16
DS Field A-18
DS Police Parameters A-19
HTTP Filter Parameter A-23

Appendix B
Configuration Examples

Differentiated Services Network Using Dynamic Filters B-2
Configuring the Router Using Site Manager B-3
Configure a Differentiated Services Interface B-4
Configure COPS B-4
Configuring the Router Using the BCC B-5
Differentiated Services Network Using Static Traffic Filters B-6
Configuring the Router Using Site Manager B-7
Configure a Differentiated Services Interface B-7
Configure a Static Filter B-8
Configuring the Router Using the BCC B-9
Queue Management and Scheduling Configuration Example B-11
Configuring a Differentiated Services Traffic Filter on an Inbound Interface B-12
Configuring RED on the Router B-12
Configuring a Weighted Queue on an Outbound Interface B-13
Configuring a Priority Queue on the Same Outbound Interface B-15
Displaying the DSQMS Configuration Using the show Command B-17

Appendix C
Using BCC show Commands

Online Help for show Commands C-2
show cops global C-2
show cops servers C-3
show diffserv global C-3
show diffserv interfaces C-4
show diffserv traffic-filter detail C-5
show diffserv traffic-filter summary C-5
show dsqms classifiers C-6
show dsqms interfaces details C-7
show dsqms interfaces stats C-8
show dsqms interfaces summary C-9
show dsqms queues detail C-9
show dsqms queues stats C-11
show dsqms queues summary C-12
show dsqms red C-13

Index

Figures

Figure 1-1. Differentiated Services Network 1-3
Figure 1-2. Architecture of the OPS Policy Server 1-5
Figure 1-3. Nortel Networks Differentiated Services Architecture 1-7
Figure 2-1. BCC Configuration Hierarchy for QMS 2-7
Figure 2-2. Relationship Between QMS Objects (Weighted RED Implementation) ... 2-8
Figure A-1. DiffServ Interface List Window A-2
Figure A-2. DiffServ Interface Record Window A-5
Figure A-3. Edit DiffServ Global Parameters Window A-6
Figure A-4. Edit COPS Global Parameters Window A-7
Figure A-5. COPS Server List Window A-9
Figure A-6. COPS Server Record Window A-15
Figure A-7. DiffServ Static Filters Window A-16
Figure A-8. Create DiffServ Template Window A-17
Figure A-9. DS Field Window A-18
Figure A-10. DS Police Window A-19
Figure A-11. Add URL Window A-23
Figure B-1. Differentiated Services Network Using Dynamic Filters B-2
Figure B-2. Differentiated Services Network Using Static Filters B-6

Tables

Table 3-1. TCP and UDP Match Criteria Parameters 3-8
Table 3-2. Common TCP Ports and Common UDP Ports 3-8
Table 3-3. Common Protocol IDs for IP Traffic 3-10
Table 3-4. Actions for DiffServ Traffic Filters 3-13
Table 3-5. DS Police Parameters 3-14
Table 5-1. Customizable COPS Server Parameters 5-5
Table 6-1. dsqms-red Object Parameters 6-2
Table 6-2. Customizable DSQMS Queue Parameters 6-5
Table 6-3. Configurable DSQMS Queue Parameters by Queue Type 6-7
Table B-1. Flow Filter on the BLN Router B-3

Preface

This guide describes differentiated services and what you do to start and customize these services on a Nortel Networks™ router.

You can use the Bay Command Console (BCC™) or Site Manager to configure differentiated services on a router. In this guide, you will find instructions for using both the BCC and Site Manager.

Before You Begin

Before using this guide, you must complete the following procedures. For a new router:

- Install the router (see the installation guide that came with your router).
- Connect the router to the network and create a pilot configuration file (see *Quick-Starting Routers*, *Configuring BayStack Remote Access*, or *Connecting ASN Routers to a Network)*.

Make sure that you are running the latest version of Nortel Networks BayRS™ and Site Manager software. For information about upgrading BayRS and Site Manager, see the upgrading guide for your version of BayRS.

Text Conventions

This guide uses the following text conventions:

angle brackets (< >)	Indicate that you choose the text to enter based on the description inside the brackets. Do not type the brackets when entering the command. Example: If the command syntax is: **ping** <*ip_address*>, you enter: **ping 192.32.10.12**
bold text	Indicates command names and options and text that you need to enter. Example: Enter **show ip** {**alerts** | **routes**}. Example: Use the **dinfo** command.
braces ({ })	Indicate required elements in syntax descriptions where there is more than one option. You must choose only one of the options. Do not type the braces when entering the command. Example: If the command syntax is: **show ip** {**alerts** | **routes**}, you must enter either: **show ip alerts** or **show ip routes**, but not both.
brackets ([ ])	Indicate optional elements in syntax descriptions. Do not type the brackets when entering the command. Example: If the command syntax is: **show ip interfaces** [**-alerts**], you can enter either: **show ip interfaces** or **show ip interfaces -alerts**.
ellipsis points (. . .)	Indicate that you repeat the last element of the command as needed. Example: If the command syntax is: **ethernet/2/1** [<*parameter*> <*value*>] **. . .** , you enter **ethernet/2/1** and as many parameter-value pairs as needed.

italic text	Indicates new terms, book titles, and variables in command syntax descriptions. Where a variable is two or more words, the words are connected by an underscore. Example: If the command syntax is: **show at** <*valid_route*> *valid_route* is one variable and you substitute one value for it.
`screen text`	Indicates system output, for example, prompts and system messages. Example: `Set Trap Monitor Filters`
separator (>)	Shows menu paths. Example: Protocols > IP identifies the IP option on the Protocols menu.
vertical line (|)	Separates choices for command keywords and arguments. Enter only one of the choices. Do not type the vertical line when entering the command. Example: If the command syntax is: **show ip** {**alerts** | **routes**}, you enter either: **show ip alerts** or **show ip routes**, but not both.

Acronyms

This guide uses the following acronyms:

COPS	Common Open Policy Service
DHCP	Dynamic Host Configuration Protocol
DNS	domain name server
DRR	deficit round robin
DSCP	differentiated services code point
DSQMS	differentiated services queue management and scheduling
EGP	Exterior Gateway Protocol
GRE	Generic Routing Encapsulation
GUI	graphical user interface
HTTP	Hypertext Transfer Protocol
ICMP	Internet Control Message Protocol
IGMP	Internet Group Management Protocol
IGP	Interior Gateway Protocol
IP	Internet Protocol
ISO	International Organization for Standardization
LDAP	Lightweight Directory Access Protocol
NHRP	Next Hop Resolution Protocol
OSPF	Open Shortest Path First
QMS	queue management and scheduling
RED	random early detection
RSVP	Resource Reservation Protocol
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
URL	uniform resource locator
WRED	weighted random early detection

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Chapter 1
Differentiated Services Overview

Differentiated services is a network architecture that lets service providers and enterprise network environments offer varied levels of service for different types of data traffic. Instead of using the "best-effort" service model to ensure data delivery, differentiated services lets you designate a specific level of performance on a packet-by-packet basis. If you have applications that require high performance and reliable service, such as voice and video over IP, you can use differentiated services to give preferential treatment to this data over other traffic.

For each packet, there is a differentiated services field in the packet header that you can mark for specific service. For IP packets, this field is called the *DS field*. The DS field has a specific value that defines how the packet is treated as it travels through the network.

Differentiated services is scalable, making it ideal for large networks. Edge devices, such as Nortel Networks routers, classify much of the data, leaving less of the processing for the core of the network. In addition, differentiated services can aggregate traffic for more efficient transmission.

Implementing Differentiated Services

In a differentiated services network, the edge router is responsible for filtering data packets and marking them for service. You can install or configure filters on the edge router using one of two methods:

- Dynamically install filters with an Optivity® Policy Services (OPS) policy server. The OPS policy server communicates with the router using the Common Open Policy Service (COPS) protocol. Flow filters are then automatically installed on the router.

- Manually configure filters on the edge router.

  You can create filters that instruct the router to mark specific packets for special service throughout the network. If you manually configure filters, there is no need for a policy server.

How you implement differentiated services depends on your specific network requirements. If you implement differentiated services with OPS, you have more flexibility and control over your network, but you have the cost and effort of maintaining a server. Conversely, if you manually configure filters, you must configure each router separately, but you do not have the added cost of maintaining a server.

Components of a Differentiated Services Network

A differentiated services network includes the following devices:

- Host

  Resides at the sending and receiving point in the network. The host is the device that requests service from the network.

- OPS policy server

  An OPS policy server installs flow filters on the edge router. These filters tell the router how to process incoming packets. The flow filter identifies packets that belong to a specific data flow and designates how packets that match the filter should be marked. The edge device and the policy server communicate using the COPS protocol. The OPS policy server is the COPS server, and the edge router is the COPS client.

  The policy server resides inside the ISP or enterprise network. It provides policy admission control, which administers network services and user authentication functions. The policy server monitors which data flows are assigned to a user and whether an application should have network access. In addition, the policy server polices data flows to limit the amount of high-priority traffic in the network. This policing prevents network resources from becoming overburdened.

- Edge router

  The edge router resides at the edge of the network. Its function is to classify data flows and mark them by setting the DS field in the IP header. The DS field designates a specific type of service for each packet and instructs the network how to process the packet.

- Core network device

  The core network device, typically a high-performance router, resides in the ISP or enterprise network. It routes data along the appropriate path through the network. This router cannot classify packets itself.

- Server manager

  The server manager, which resides outside the network, sets up video conferences. The server manager is not a required part of a differentiated services network.

Figure 1-1 shows a differentiated services network that includes a server manager and a policy server. If you manually configure filters, the policy server and server manager would not be included.

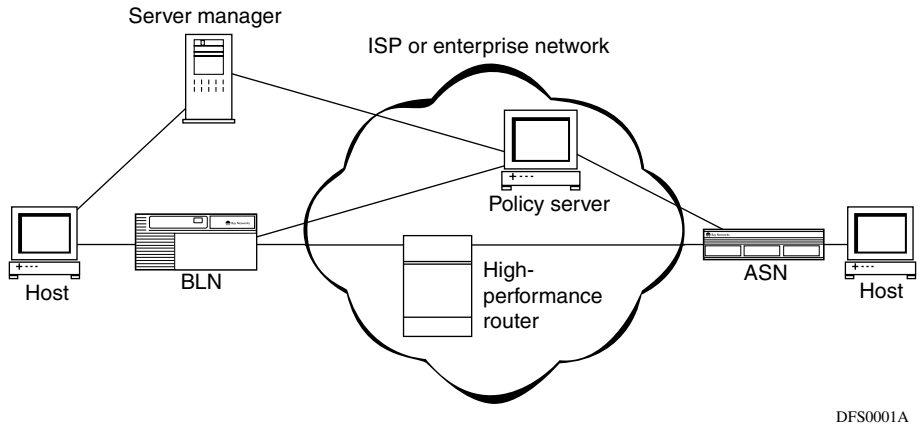


Figure 1-1. Differentiated Services Network

Communicating with the OPS Policy Server

If your differentiated services network uses an OPS policy server, the router uses the COPS protocol to communicate with the policy server. The router is the COPS client. The COPS client uses the Transmission Control Protocol (TCP) to communicate with the policy server. The COPS client can connect to only one server at a time, choosing the server from a list of servers that you define.

When the router requests a filter from the policy server, the server responds with its own request to perform one or more of the following actions:

- Install a new filter.
- Update an existing filter.
- Disable or enable an existing filter.
- Delete an existing filter.

For each request, the COPS client on the router takes the necessary action and then sends an acknowledgment back to the policy server. The policy server can also send unsolicited requests.

If an interface on the router becomes inactive or terminates, the COPS client deletes all filters from that interface. After the interface recovers, the router needs to request the filters from the policy server again. If the connection to the policy server is temporarily lost, the COPS client software attempts to reconnect to the server. In this case, the router does not delete the filters.

The policy server assigns an ID to each filter before it installs the filter on the router. The policy server can then change an installed filter based on that ID. If the policy server requests an update or the removal of a nonexistent filter, the router ignores the request and sends an error message to the policy server. You can view the filters installed by the policy server using the router's traffic filters feature, but you cannot modify them.

For more information about configuring the OPS policy server, see *Managing Policy Information in Optivity Policy Services*.

Figure 1-2 shows the Nortel Networks OPS policy server architecture.

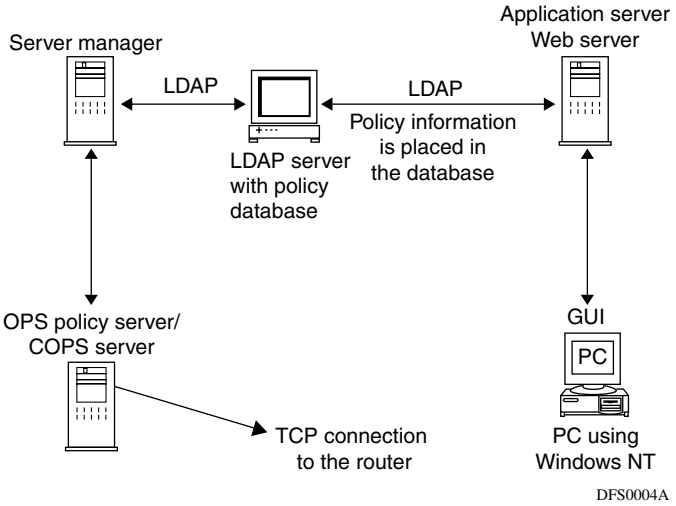


Figure 1-2. Architecture of the OPS Policy Server

Marking Packets for Specific Services

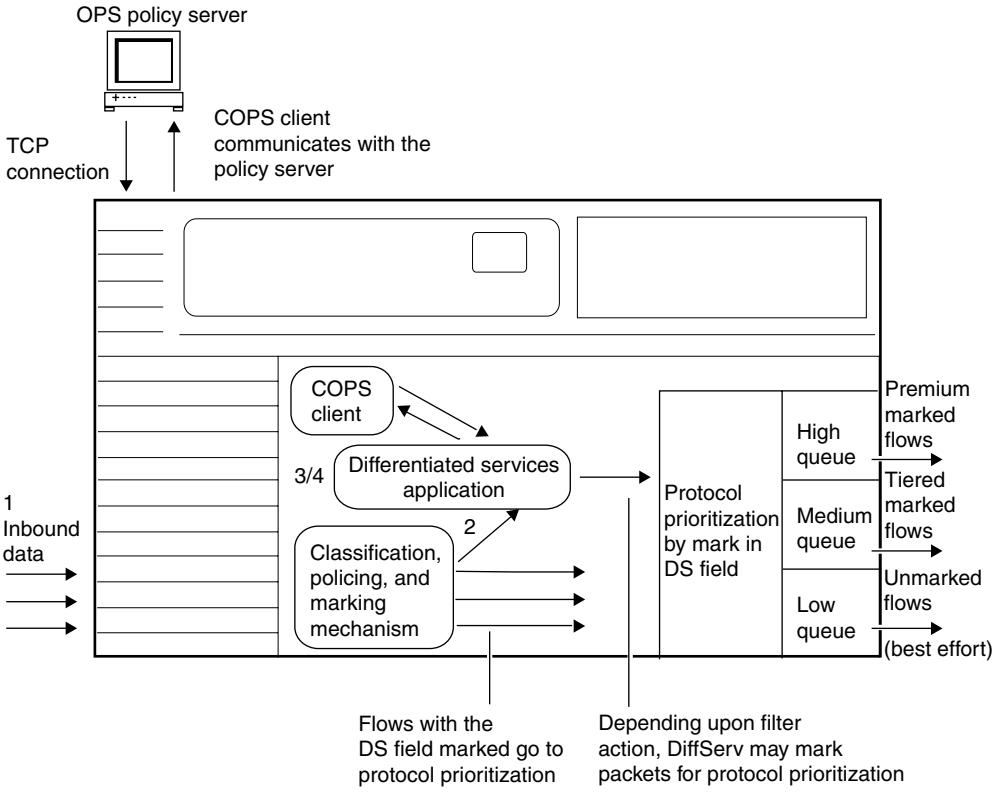
A packet's assigned level of service determines whether the packet receives preferential treatment as it travels through the network. The DS field has a specific value that determines the service.

If the router communicates with a policy server, the process of installing filters and marking packets is as follows:

1. The edge router contacts the policy server with a configuration request. This happens automatically as part of the router's normal differentiated services activity for each differentiated services interface.
2. The policy server responds by downloading a set of flow filters from its database to the edge router.
3. When a packet arrives at a router's differentiated services interface, the router checks its flow filters, if any are installed, to see whether the packet matches the filter's criteria.

4. Packets that match the flow filter criteria are marked by the differentiated services application with a DS-field pattern specified by the filter. The value in the DS field determines whether the packet is sent to a high-priority data queue for preferential treatment.
5. After a packet is marked, it is sent to the core network device where, depending on the marking, the packet receives preferential treatment as it is routed through the network and on to the destination host.

Figure 1-3 shows the Nortel Networks differentiated services architecture and how the router marks a packet.



1. Router receives data.
2. There is a filter match and the differentiated services application is notified.
3. Router examines filter action specified in policy obtained from policy server.
4. Differentiated services application applies actions to packets meeting the filter criteria.

DFS0005A

Figure 1-3. Nortel Networks Differentiated Services Architecture

URL Filters

The router can filter and mark Hypertext Transfer Protocol (HTTP) traffic based on uniform resource locator (URL) strings. For the router to use a URL filter, the filter must be installed by the policy server or configured manually. The filter must contain the URL string and optionally, any of the following information:

- Source IP address
- Destination IP address
- Destination port (the default port is 80)

Only the URL string is required, but for efficient data transmission, it is useful to also include one of the other filter criteria.

After the flow filters are configured on the router, the router can mark inbound HTTP traffic for transmission through the network. If the router receives data that matches a URL filter, the router installs another filter, called the *dynamic filter*, on the next-hop interface, which is an interface on this same router.

The dynamic filter is available for the duration of the HTTP session. The dynamic filter is deleted if there is no data activity during the time period specified by the URL idle out timer. The original URL filter remains installed on the router.

For information about setting the URL idle out timer, see “Modifying a Differentiated Services Interface” on page 4-2.

Note: Even if you configure URL filters manually (static configuration), the differentiated services application uses COPS to install the dynamic filter. URL filters are the only filters that create these dynamic filters.

You must configure differentiated services on all possible next-hop interfaces on the router, or at least on all next-hop interfaces where the HTTP servers can reside. Otherwise, the router will not be able to mark the return packets.

Queue Management and Scheduling (QMS)

BayRS includes queue management and scheduling (QMS) mechanisms to support differentiated services. The weighted random early detection (WRED) algorithm is used for queue management to drop packets selectively based on packet preference. A queue scheduling algorithm called deficit round robin (DRR) provides fair queuing.

Queue Management Using WRED

Random early detection (RED) is a popular algorithm for queue management. RED is an active queue management algorithm that drops packets when congestion is detected, before a queue becomes full. RED allows selective dropping of packets.

RED works on a time-averaged queue length, not an instantaneous one, to prevent problems with low-bandwidth, high-burst queues. Packets are dropped from queues on a probability basis, which increases as the average queue size grows. When a queue reaches the **max-threshold** value set for the associated RED function (the default is 80%), probability reaches 100 percent.

The router computes average queue size and can detect oncoming congestion. When the **min-threshold** value is reached, the router begins dropping packets in direct relation to any increase in average queue size until the average queue size falls below the **min-threshold** value. If the originating router is using TCP, it detects packet loss, requests a re-send, and reduces the window size for acknowledgment. In effect, it reduces the transmission rate in response to congestion.

The BayRS implementation of DSQMS allows a mix of strict priority queuing and bandwidth allocation on a single interface. Flows entering either a weighted or a priority queue can then be managed by RED. Assigning different RED functions to each traffic class (DSCP) is known as weighted RED or WRED.

The process of assigning different drop probabilities (WRED) on a per flow or class (DSCP) basis allows a more granular approach to managing flows or traffic types of different packet sizes. You can configure WRED on a queue-by-queue basis.

Queue Scheduling Using DRR

Differentiated services traffic filters sort incoming IP traffic and mark it with a particular differentiated services code point (DSCP, formerly known as type of service or ToS). Based on the DSCP, the router will queue traffic and then schedule it for transmission. The DSCP marking allows DSQMS to separate packets into classes and place them in queues that enable the router to handle each class of traffic differently.

Queue scheduling manages the allocation of bandwidth among queues. Queue scheduling affects the sequence in which the data leaves the WAN interface; it does not affect traffic as it enters the router.

Like the queue management function, differentiated services queue scheduling supports a mix of priority and bandwidth allocation (or weighted) queues. For example, you could sort delay-sensitive traffic into two priority queues configured for strict dequeuing and dedicate 10% of the link bandwidth to these two queues. The remaining 90% of the link bandwidth could be shared among three weighted fair queues, each configured with a percentage of bandwidth (or weight).

Priority queues are scheduled first, and the amount of traffic dequeued is determined by a configurable timer, called a *priority time quantum,* so that subsequent priority and weighted queues are serviced.

Weighted queues are serviced in round-robin fashion. In this scheme, a high-bandwidth link with larger packets can consume more than its weighted share compared to a low-bandwidth link with smaller packets. To prevent this problem, link bandwidth, weight, and an average “one-round” service timer are calculated together to create a *queue quantum* that determines scheduling.

The scheduler selects a queue to transmit from and its queue quantum is determined. As packets leave the queue, its queue quantum balance is decreased by the packets’ size. The scheduler moves to the next queue when the current queue’s balance becomes negative, at which time the queue is considered in deficit. This is the “deficit” element of deficit round robin. The scheduler counts the deficit against the queue quantum balance on the next round-robin dequeuing pass.

Chapter 2
Starting Differentiated Services

The quickest way to configure differentiated services on the router is to enable it with the default configuration that Nortel Networks software supplies. This configuration uses all available default values for the interface and COPS parameters. You need to supply values only for required parameters.

This chapter includes the following topics:

Topic	Page
Planning for a Differentiated Services Network	2-2
Starting Configuration Tools	2-2
Preparing a Configuration File	2-2
Starting Differentiated Services Using the BCC	2-3
Starting Differentiated Services Using Site Manager	2-5
Configuring Queue Management and Scheduling	2-7
Where to Go Next	2-13

Planning for a Differentiated Services Network

This guide primarily explains how to configure a Nortel Networks router as a differentiated services edge device.

For the router to successfully operate in a differentiated services network, you must obtain the following information before you configure differentiated services on the router:

- The IP address of the policy server.
- The COPS client IP address and ID of the router. Provide this information to the administrator configuring the policy server.

Starting Configuration Tools

Before you configure differentiated services, refer to the following user guides for instructions on how to start and use the Nortel Networks configuration tool of your choice. (You must use the BCC to configure queue management and scheduling.)

- *Using the Bay Command Console (BCC)*
- *Configuring and Managing Routers with Site Manager*

These guides also describe generally how to create and modify a device configuration.

Preparing a Configuration File

Before starting differentiated services, you must create and save a configuration file with at least one IP interface. The physical interface can be any LAN port, for example, Ethernet or token ring.

For information about creating a configuration file, see *Quick-Starting Routers*.

You can start differentiated services using the BCC or Site Manager.

Starting Differentiated Services Using the BCC

Starting differentiated services involves enabling differentiated services on the router, choosing a filter mechanism, and enabling the COPS protocol (if applicable).

Enabling Differentiated Services

To enable differentiated services on the router using the BCC, you must first add differentiated services globally to the router and then add it to each interface that will support differentiated services.

Note: The BCC will not let you configure differentiated services on an interface that has traffic filters. You must first delete the traffic filters before you can add differentiated services to the interface.

To configure differentiated services globally on the router with the default settings:

1. **In configuration mode, navigate to the global IP prompt (for example, box; ip).**

   ```
   box# ip
   ip#
   ```

2. **Configure differentiated services for IP.**

   ```
   ip# diffserv
   diffserv#
   ```

To configure differentiated services on an IP interface:

1. **Navigate to the IP interface prompt (for example, box; ethernet/2/2; ip/2.2.2.2/255.0.0.0).**
2. **Enable differentiated services on the interface.**

   ```
   ip/2.2.2.2/255.0.0.0# diffserv
   diffserv/2.2.2.2#
   ```

The BCC assigns default values to all differentiated services parameters.

Choosing a Filter Mechanism

When you enable differentiated services, you must select a mechanism for installing filters on the router. The router uses filters to determine which packets it should mark for special treatment through the network. You can either enable the COPS protocol or manually configure filters.

Go to one of the following sections to configure a filter mechanism:

- "Enabling COPS" (next section)
- "Creating Static Filters Using the BCC" on page 3-5

Enabling COPS

If the router will receive filters from a policy server, enable COPS so that the router can communicate with the policy server.

To enable COPS:

1. **In configuration mode, navigate to the top-level box or stack prompt.**
2. **Enable COPS, providing the router differentiated services IP address that will be the COPS client address and an alphanumeric identification for the router.**

   ```
   box# cops address 2.2.2.2 id athens
   cops#
   ```

3. **Configure a COPS server, providing the IP address of a policy server.**

   ```
   cops# cops-server 192.1.1.1
   cops-server/192.1.1.1# back
   cops#
   ```

4. **Navigate to the IP interface on which you are configuring differentiated services (for example, box; serial/5/1; ppp; ip/2.2.2.2/255.0.0.0).**
5. **Enable COPS on the interface:**

   ```
   ip/2.2.2.2/255.0.0.0# diffserv config-type cops
   diffserv/2.2.2.2#
   ```

Starting Differentiated Services Using Site Manager

Starting differentiated services involves enabling differentiated services on an IP interface, choosing a filter mechanism, and enabling the COPS protocol (if applicable).

Enabling Differentiated Services

In Site Manager, you need only configure differentiated services on a per-interface basis.

Note: The router does not allow IP traffic filters on a differentiated services interface. If you add differentiated services to an interface that already has IP traffic filters configured, Site Manager will remove the traffic filters.

To enable differentiated services on an IP interface, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, click on an IP interface connector.	The Add Circuit window opens.
2. Accept the default circuit name or enter a new name, then click on **OK**.	The Select Protocols window opens.
3. Scroll through the list of protocols and choose **DiffServ**, then click on **OK**.	The IP Configuration window opens.
4. Enter the interface's IP address and mask.	
5. Click on **OK**.	The DiffServ Interface List window opens.
6. If you want to enable COPS, go to "Enabling COPS" on page 2-6. Otherwise, click on **Done**.	You return to the Configuration Manager window.

Choosing a Filter Mechanism

When you enable differentiated services, you must select a mechanism for installing filters on the router. The router uses filters to determine which packets it should mark for special treatment through the network. You can either enable the COPS protocol or manually configure filters.

Go to one of the following sections to configure a filter mechanism:

- "Enabling COPS" (next section)
- "Creating Static Filters Using Site Manager" on page 3-17

Enabling COPS

To enable COPS, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the DiffServ Interface List window, set the **Config Type** parameter to **COPS**. Click on **Help** or see the parameter description on page A-4.	
2. Click on **Apply**.	Site Manager displays a message informing you that the static filters will be deleted and asks if you want to continue.
3. Click on **OK**.	
4. Click on **COPS Global**.	The Edit COPS Global Parameters window opens.
5. Set the following parameters: • **Client IP Address** • **Client ID** Click on **Help** or see the parameter descriptions beginning on page A-8.	
6. Click on **OK**.	You return to the DiffServ Interface List window.
7. Click on **COPS Servers.**	The COPS Server List window opens.
8. Click on **Add**.	The COPS Server Record window opens.
9. Set the **IP Address** parameter. Click on **Help** or see the parameter description on page A-16.	
10. Click on **OK**.	You return to the COPS Server List window, with the server entry listed.
11. Click on **Done**.	You return to the DiffServ Interface List window.
12. Click on **Done**.	You return to the Configuration Manager window.

Configuring Queue Management and Scheduling

To configure queue management and scheduling for differentiated services, you must use the BCC configuration tool. Figure 2-1 illustrates the BCC configuration hierarchy for queue management and scheduling (DSQMS).

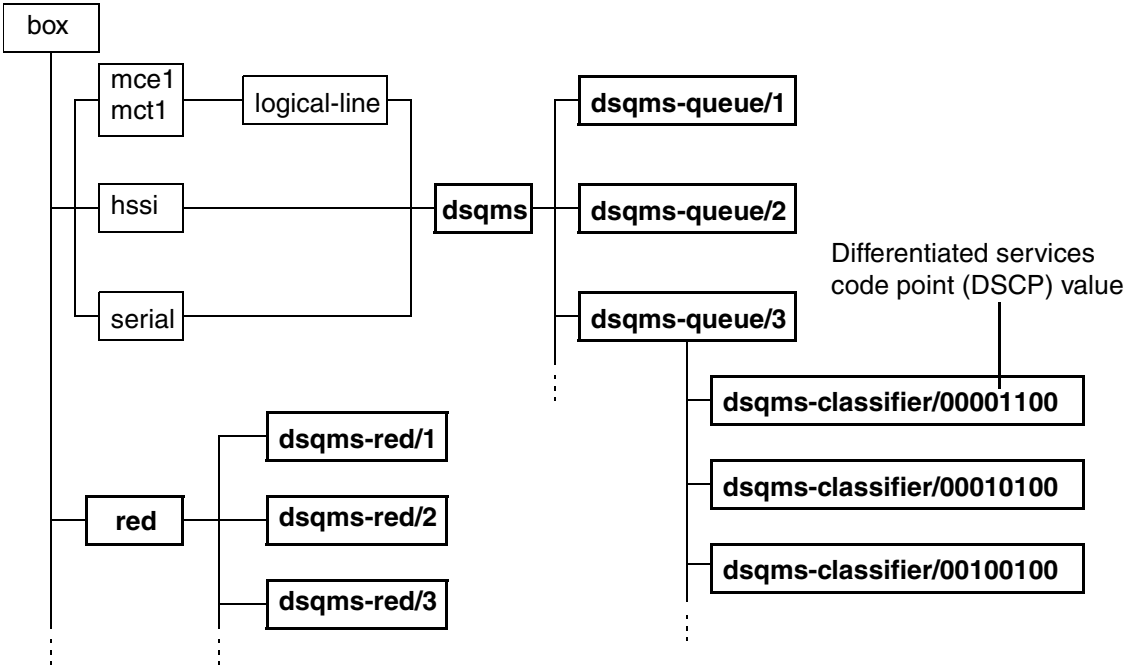


Figure 2-1. BCC Configuration Hierarchy for QMS

How DSQMS Elements Work Together

Weighted RED (WRED) is the ability to assign different drop probabilities to specified traffic flows within the same queue. To implement WRED, you must first enable the RED algorithm on the router. (For more information about WRED, see "Queue Management and Scheduling (QMS)" on page 1-9.)

After you enable RED, configure one or more instances of dsqms-red, each with different settings. Each instance of dsqms-red defines a set of attributes for use of the RED function. These instances of dsqms-red are used by one or more traffic classifiers in one or more managed queues, as shown in Figure 2-2.

The traffic classifiers within a DSQMS queue sort traffic based on the differentiated services code point (DSCP) in the traffic headers. Traffic that matches a traffic classifier is treated according to the attributes configured for the queue and according to the referenced dsqms-red instance's attributes, if applicable. (Not all traffic classifiers reference a dsqms-red instance.) Figure 2-2 shows these relationships.

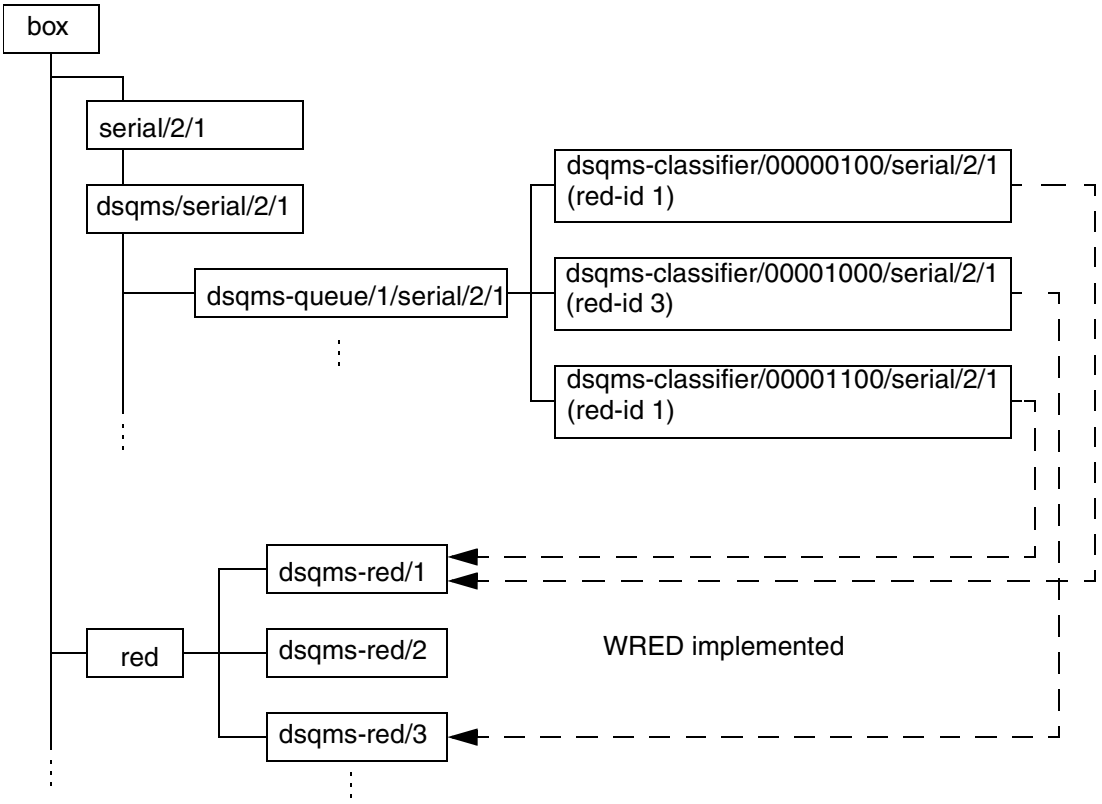


Figure 2-2. Relationship Between QMS Objects (Weighted RED Implementation)

Implementation Notes

The following guidelines can help you successfully configure DSQMS on your router:

- You can configure DSQMS on these interfaces only: HSSI, MCT1, MCE1, and synchronous.
- If you enable flow fairness on a queue, you cannot configure that queue as a best-effort queue. For information about enabling flow fairness on a queue or designating the queue as best effort, see "Modifying a DSQMS Queue" on page 6-5.
- If you configure both weighted and priority queues on an interface, you may experience latency problems with the highest priority queues. To avoid such problems:
  - -- Set the DSQMS interface parameter **dequeue-at-line-rate** to **enabled** (the default value is **disabled**). See "Configuring DSQMS to Dequeue Packets at Line Rate" on page 6-3 for instructions.
  - -- Ensure that the amount of high-priority traffic is not excessive in the highest priority queues.
- If you implement RED for queue management instead of tail-drop (that is, you set the queue parameter **drop-type** to **red** and you associate the queue classifier with a RED function), the probability of dropping packets may adversely affect the latency requirements of some applications. Adjust the following parameters to achieve the required latency levels for the queue:
  - -- RED parameters **min-threshold** and **max-threshold** (see "Modifying RED Parameters" on page 6-2 for instructions).
  - -- Queue parameters **average-queue-gain** and **idle-queue-loss-rate** (see "Modifying a DSQMS Queue" on page 6-5 for instructions).

DSQMS Configuration Steps

To configure DSQMS, you perform the following steps. Each step is described in the following sections:

1. Enable the weighted RED algorithm on the router.
2. Create one or more sets of attributes (**dsqms-red** objects) that can be used by queues on the interfaces.
3. Enable DSQMS on an interface.
4. Create one or more queues on the interface.
5. Create one or more traffic classifiers on the queue.

To see an extended example of an initial DSQMS configuration, see "Queue Management and Scheduling Configuration Example" on page B-11.

Enabling the RED Algorithm

You must enable the RED algorithm to configure instances of dsqms-red. To enable RED, navigate to the top-level box or stack prompt and enter:

red

For example, the following command enables RED on a router:

```
box# red
red#
```

RED has no configurable parameters.

Configuring an Instance of dsqms-red

To add an instance of dsqms-red to the configuration, navigate to the RED prompt (for example, **box; red**) and enter:

dsqms-red id <*id_number*> [**min-threshold** <*min_value*>] [**max-threshold** <*max_value*>] [**first-order-const** <*first_value*>] [**second-order-const** <*second_value*>]

id_number is a simple numerical identifier that identifies the instance (set of attributes) for reference by traffic classifiers.

min_value is the queue size below which no packets are dropped by RED.

max_value is the queue size above which all packets are dropped by RED.

first_value is the first order constant used when calculating drop probability based on the average queue fraction, the queue size, and the min-threshold value.

second_value is the second order constant used when calculating drop probability based on the average queue fraction, the queue size, and the min-threshold value.

For example, the following command adds the first instance of dsqms-red:

```
red# dsqms-red id 1
dsqms-red/1#
```

This command sets up one dsqms-red instance with the default values for how RED functions. You can change these values and create additional dsqms-red instances with different values. For more information, see "Modifying RED Parameters" on page 6-2.

Configuring DSQMS on an Interface

After you enable RED, perform the following steps to set up DSQMS on one or more interfaces:

1. Enable DSQMS on one or more interfaces.
2. Configure a DSQMS queue on the interface.
3. Configure a traffic classifier for the queue.

These steps are described in detail in the following sections.

Enabling DSQMS on an Interface

To enable DSQMS, navigate to the prompt for the interface where you want to use DSQMS, and enter:

dsqms

For example, the following command enables DSQMS on serial interface 2/1:

```
serial/2/1# dsqms
dsqms/serial/2/1#
```

Adding a DSQMS Queue to an Interface

To configure a DSQMS queue on an interface, navigate to the DSQMS prompt for the interface (for example, **box; serial/2/1; dsqms**) and enter:

dsqms-queue id <*id_number*>

id_number is a simple numerical identifier for the queue.

For example, the following commands create the first DSQMS queue on serial interface 2/1 and enable the queue (you must manually enable the queue):

```
dsqms/serial/2/1# dsqms-queue id 1
dsqms-queue/1/serial/2/1# state enabled
dsqms-queue/1/serial/2/1#
```

Note: Unlike most BCC objects, which are enabled by default when you create them, a DSQMS queue is disabled by default (the **state** parameter is set to **disabled**). You must explicitly enable the queue.

DSQMS queues have a number of parameters that you use to customize DSQMS for your requirements. See "Modifying a DSQMS Queue" on page 6-5.

If you want to add traffic classifiers to the queue, go to the next section. If you have finished configuring the queue, you must manually start DSQMS on the interface by entering the **restart** command at the DSQMS interface prompt:

```
dsqms-queue/1/serial/2/1# back
dsqms/serial/2/1# restart set
dsqms/serial/2/1#
```

Adding a Traffic Classifier to a Queue

To configure a traffic classifier for a queue, navigate to the DSQMS queue prompt (for example, **box; serial/2/1; dsqms; dsqms-queue 1**) and enter:

dsqms-classifier dscp <*binary_octet*> [**red-id** <*dsqms_red_id_number*>]

binary_octet is the 8-digit differentiated services code point value found in packet headers to distinguish how differentiated services should classify incoming traffic.

dsqms_red_id_number is the numerical identifier of the dsqms-red instance that this traffic classifier will use to manage traffic. This parameter is optional.

For example, the following command configures a traffic classifier on the first queue on serial interface 2/1:

```
dsqms-queue/1/serial/2/1# dsqms-classifier dscp 00001100 red-id 1
dsqms-classifier/00001100/serial/2/1#
```

Typically, you create additional queues and additional traffic classifiers with different RED functions within each queue. See Figure 2-2 on page 2-8.

If you want to add other traffic classifiers to the queue or other queues to the interface, use the instructions in this section. If you have finished configuring the queue, you must manually start DSQMS on the interface by entering the **restart** command at the DSQMS interface prompt:

```
dsqms-classifier/00001100/serial/2/1# back
dsqms-queue/1/serial/2/1# back
dsqms/serial/2/1# restart set
dsqms/serial/2/1#
```

Where to Go Next

After you complete the steps in this chapter, differentiated services should be operating on at least one interface.

- If you chose to manually configure traffic filters, go to Chapter 3, “Configuring Static Traffic Filters for Differentiated Services.”
- To customize the differentiated services configuration, go to Chapter 4, “Customizing Differentiated Services.”
- To customize COPS services, go to Chapter 5, “Customizing COPS.”
- To customize DSQMS, go to Chapter 6, “Customizing Queue Management and Scheduling.”

Chapter 3
Configuring Static Traffic Filters for Differentiated Services

If you do not have a policy server or if you chose to use static traffic filters when you started differentiated services, you must create traffic filters. This chapter describes how to create differentiated services traffic filters and includes the following topics:

Topic	Page
DiffServ Traffic Filter Concepts and Terminology	3-1
Creating Static Filters Using the BCC	3-5
Creating Static Filters Using Site Manager	3-17
Where to Go Next	3-22

DiffServ Traffic Filter Concepts and Terminology

This section provides background information for the sections on configuring traffic filters that follow it.

Traffic Filter Templates

A traffic filter template is a reusable, predefined specification for a traffic filter. It consists of a complete filter specification, but is not associated with a specific differentiated services interface. Each traffic filter template must have a unique name, preferably one that identifies its function.

You can create and use differentiated services traffic filter templates only when working in Site Manager. The BCC does not support differentiated services traffic filter templates.

Traffic Filters

Differentiated services traffic filters mark packets in their DS field for special treatment through the network. Using traffic filters, you can lower or raise the packets' priority or control drop probability for types of traffic using DSQMS and RED.

Each traffic filter has the following properties:

- A unique name, preferably one that identifies its function
- An optional filter precedence value

You create differentiated services traffic filters on a differentiated services interface. You can apply a traffic filter template to the filter if you are working in Site Manager.

Traffic filter templates and traffic filters contain the following components:

- Criteria

  The portion of the incoming packet, frame, or datagram header to be examined

- Ranges

  Numeric values (often addresses) to be compared with the contents of examined packets

- Actions

  What happens to packets that match the criteria and ranges specified in the traffic filter

Filter Precedence

To specify a traffic filter's relative priority among other traffic filters applied to the differentiated services interface, you assign the traffic filter a precedence value. If you do not explicitly assign a precedence when you create the traffic filter, the software automatically assigns a precedence equal to the highest priority value plus 1.

For example, if a differentiated services interface has only two traffic filters, one with a precedence of 2 and the other with a precedence of 3, and you assign a new filter without explicitly identifying a precedence, the software assigns a precedence of 4 to the newly added filter. To avoid the need to explicitly assign precedence numbers, assign the traffic filters to a differentiated services interface in the same order that you want the software to compare them to each packet.

You can specify a precedence value from 1 through 127. The lower the precedence value, the higher its priority. Thus, if a filter has a precedence of 1, the software always processes that filter first for each incoming packet.

The software displays an error message if you attempt to assign a filter to an interface that already has the maximum number of filters (127). If a differentiated services interface has fewer that 127 filters, but has a filter with a precedence of 127, you cannot add another filter unless you explicitly assign a precedence less than or equal to an available precedence.

Filter Criteria

When you create a differentiated services traffic filter template or a differentiated services traffic filter, you must supply filter criteria and actions.

You can filter traffic based on specified bit patterns in one of the following headers in an IP datagram:

- IP header (including the DSCP)
- Header of the upper-layer protocol (TCP or UDP)

Another feature unique to differentiated services filters is that you can use URLs as filter criteria, which enables the router to mark HTTP packets.

You define a criterion for creating differentiated services traffic filters based on bit patterns in the packet header. You apply user-defined criteria by specifying changes to the DSCP in the packet header.

Filter Actions

The filter action determines what happens to packets that match the filter criteria. You can configure differentiated services traffic filters to perform the following actions:

- Log — For every packet that matches the filter entry, the router enters a message in the event log. You can specify this action together with other actions.
- Accept — The router forwards a packet without marking it.
- Drop — The router does not route any packet that matches the filter criteria.
- Mark (the Site Manager **DiffServ Set Field** command) — The router sets the DS byte in the IP header for all packets that match the filter criteria.
- Police (the Site Manager **DiffServ Set Police** command) — The router monitors the packet flow and determines whether that packet is in or out of the profile. If the packet fits the profile, the router sets the DS byte.

For every packet that matches the filter criteria, the router sends an entry to the system event log if you configure the log action.

Creating Static Filters Using the BCC

To create a differentiated services traffic filter on a differentiated services interface, enter the following command:

traffic-filter filter-name *<name>* [**precedence** *<number>*]

name is the name of the new differentiated services traffic filter.

number is any integer from 1 through 127. The software uses the precedence value to determine the relative position of the filter in the sequence of filters to be applied to each packet. The traffic filter with a precedence of 1 is always applied first, and the traffic filter with a precedence of 127 is always applied last. If you do not specify a precedence, the software automatically assigns a precedence equal to the greatest precedence value on that interface plus 1.

Caution: Applying traffic filters to a differentiated services interface without regard to their relative precedence can produce unwanted results. For more information, see "Filter Precedence" on page 3-3.

Example - Creating a Traffic Filter

This example creates a traffic filter named "nortel" with no predefined precedence value. The BCC calculates the next highest precedence value. Later this filter will be set to match HTTP traffic from Nortel Networks. To create a differentiated services traffic filter:

1. **Navigate to the differentiated services interface prompt (for example, box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv).**
2. **Configure a differentiated services filter. You must supply a filter name.**

```
diffserv/2.2.2.2# traffic-filter filter-name nortel
ds-filter/nortel/2.2.2.2#
```

You must set both filter criteria and filter actions to complete the creation of a static filter. For more information, refer to the sections that follow and use the **info** and **?** (question mark) commands at the differentiated services traffic filter prompt.

Specifying Match Criteria

The match criteria in a filter specify which fields in the IP header of each packet must contain the values that you specify. You can also specify certain fields in the headers of TCP and UDP packets contained in the IP data field of IP packets.

To prepare to specify the filtering criteria, navigate to the traffic filter prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel**) and enter:

match

You can specify match criteria for filters as described in the following sections:

Topic	Page
Source and destination network	3-6
Source and destination TCP and UDP port	3-7
Protocol identifier	3-9
DS field	3-10
URLs	3-11
TCP packets with ACK and RESET bits in the header	3-11
User-defined criteria	3-12

Specifying Source and Destination Networks As Match Criteria

To filter on source and destination networks, go to the match prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; match**) and do the following for each source and destination network that you want to filter on:

1. **Enter the following command:**

   {source | destination}-network *<address_range>*

   address_range specifies a range of IP addresses for source and destination networks.

   The source network or destination network prompt appears.

2. **Go back to the match prompt:**

   back

Example - Source and Destination Network Criteria

```
match/ds-filter/nortel/2.2.2.2# source-network 2.2.2.2-4.4.4.4
source-network/ds-filter/nortel/2.2.2.2-4.4.4.4# back
match/ds-filter/nortel/2.2.2.2# destination-network 4.4.4.4-5.5.5.5
destination-network/ds-filter/nortel/4.4.4.4-5.5.5.5# back
match/ds-filter/nortel/2.2.2.2#
```

Specifying Source and Destination TCP and UDP Ports As Match Criteria

To filter on TCP ports, UDP ports, or both, you can specify only one of the following criteria for each filter:

- Source TCP ports, destination TCP ports, or both
- Source UDP ports, destination UDP ports, or both
- Both destination TCP and UDP ports
- Both source TCP and UDP ports

After you specify one of these options, the BCC prevents you from specifying another in the same filter. For example, if you specify source TCP ports, you can also specify destination TCP ports, but you cannot specify source UDP ports.

When you specify one of these values, the BCC automatically assigns the associated protocol ID (6 for TCP or 17 for UDP) to the protocol parameter. Therefore, you cannot modify the protocol parameter of a filter that specifies a TCP or UDP port value.

To filter on TCP or UDP ports, navigate to the match prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; match**) and enter the following command:

<parameter> {*<range_of_ports>*}

parameter is one of the following (Table 3-1):

Table 3-1. TCP and UDP Match Criteria Parameters

Parameter	Specifies
src-tcp-ports	Source TCP port through which traffic is entering the network
dest-tcp-ports	Destination TCP port through which you are directing outbound network traffic
src-udp-ports	Source UDP port through which traffic is entering the network
dest-udp-ports	Destination UDP port through which you are directing outbound network traffic
dest-tcp-udp-ports	Both destination TCP and UDP ports through which you are directing outbound network traffic
src-tcp-udp-ports	Both source TCP and UDP ports through which traffic is entering the network

range_of_ports is a space-delimited list.

Table 3-2 lists some common TCP port and UDP port values.

Table 3-2. Common TCP Ports and Common UDP Ports

Description	TCP Port
FTP	20, 21
Telnet	23
SMTP	25
DNS	53
Gopher	70
HTTP	80-84
DLSw read port	2065
DLSw write port	2067

Description	UDP Port
DNS	53
TFTP	69
SNMP	161
SNMPTRAP	162

Example - Source TCP Port

This example specifies source TCP ports 20, 80, and 53 through 56 as match criteria for the filter "nortel":

```
match/ds-filter/nortel/2.2.2.2# src-tcp-ports {20 80 53-56}
match/ds-filter/nortel/2.2.2.2#
```

Example - Destination TCP Port

This example specifies destination TCP ports 30, 90, and 50 through 53 as match criteria:

```
match/ds-filter/nortel/2.2.2.2# dest-tcp-ports {30 90 50-53}
match/ds-filter/nortel/2.2.2.2#
```

Example - Source UDP Port

This example specifies source UDP port 162 as a match criterion:

```
match/ds-filter/nortel/2.2.2.2# src-udp-ports 162
match/ds-filter/nortel/2.2.2.2#
```

Example - Destination TCP and UDP Ports

This example specifies both destination TCP and UDP ports 53 as match criteria:

```
match/ds-filter/nortel/2.2.2.2# dest-tcp-udp-ports 53
match/ds-filter/nortel/2.2.2.2#
```

Specifying Protocol Identifiers As Match Criteria

Internet Protocol Version 4 (IPv4) specifies an 8-bit protocol field to identify the next-level protocol. You can use the protocol field to identify traffic that you want to filter on.

Note: If you filter on a TCP or UDP source or destination, the software automatically changes the value to the protocol number associated with TCP or UDP.

If you specify a protocol other than TCP or UDP, the software prevents you from filtering on the TCP or UDP source or destination. Otherwise, the offset associated with one of the parameters in the non-UDP/TCP packet could coincidentally match the filter, and the software would perform the filter's action.

To filter traffic using the protocol field, go to the match prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; match**) and enter the following command:

protocol {*<list_of_protocols>***}**

list_of_protocols can include any number of protocol identifiers. It can also specify ranges of protocol identifiers.

Table 3-3 lists some common protocol ID codes for IP traffic.

Table 3-3. Common Protocol IDs for IP Traffic

Protocol	ID Code (Decimal)
ICMP (Internet Control Message Protocol)	1
IGMP (Internet Group Management Protocol)	2
TCP (Transmission Control Protocol)	6
EGP (Exterior Gateway Protocol)	8
IGP (Interior Gateway Protocol)	9
UDP (User Datagram Protocol)	17
RSVP (Resource Reservation Protocol)	46
GRE (Generic Routing Encapsulation)	47
NHRP (Next Hop Resolution Protocol)	54
OSPF (Open Shortest Path First)	89

Example - Protocol Identifier Criteria

To match IGP and OSPF packets, enter the following command:

```
match/ds-filter/nortel/2.2.2.2# protocol {9 89}
match/ds-filter/nortel/2.2.2.2#
```

Specifying the DS Field As a Match Criterion

Differentiated services establishes an 8-bit field in the IP traffic header referred to as the differentiated services code point (DSCP), or DS field. The DS field may be altered by the filter actions of other differentiated services nodes in the network. You can filter on the DS field to take advantage of prior DS field marking in your network.

To filter on the DS field, go to the match prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; match**) and enter the following command:

ds-field *<octet>*

octet specifies a binary DSCP from 00000000 through 11111100. Differentiated services does not use the last two bits of the octet.

Example - DS Field Criterion

To match packets with a DSCP value of 11100000, enter the following command:

```
match/ds-filter/nortel/2.2.2.2# ds-field 11100000
match/ds-filter/nortel/2.2.2.2#
```

Specifying URLs As Match Criteria

To filter on URLs, go to the match prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; match**) and enter the following command:

urls {*<first_url> <second_url> ... <last_url>*}

first_url and the arguments that follow specify one or more URLs to filter. When specifying multiple URLs, separate each one with a space.

Example - URL Criteria

```
match/ds-filter/nortel/2.2.2.2# urls {www.nortelnetworks.com www.nortel.com}
match/ds-filter/nortel/2.2.2.2#
```

Specifying TCP-Established Match Criteria

By default, the router does not filter packets on the ACK and RESET bits in the TCP header. To allow the router to filter packets with the ACK and RESET bits, go to the match prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; match**) and enter the following command:

tcp-established {on | off}

Example - TCP-Established Criteria

In this example, the router filters packets with the ACK and RESET bits in the TCP header turned on.

```
match/ds-filter/nortel/2.2.2.2# tcp-established on
match/ds-filter/nortel/2.2.2.2#
```

Specifying User-Defined Match Criteria

You can specify user-defined criteria in differentiated services traffic filters by specifying an offset and length based on the reference fields in the IP header.

To specify user-defined criteria, go to the match prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; match**) and enter:

user-defined reference *<value>* **offset** *<value>* **bitwidth** *<value>* **range** *<value>*

reference is a known bit position in the packet header, either **start-ip-header** or **end-ip-header**.

offset specifies the first position of the filtered bit pattern in relation to the reference point (measured in bits).

bitwidth specifies the total bit length that matches the packet criteria.

range specifies a minimum and maximum target value to apply to the match criterion. For a single value, you must specify the minimum value in hexadecimal format. You can precede the value with 0x.

Example - User-Defined Criteria

This example specifies user-defined criteria to create an IP traffic filter that drops every packet that has a value of 192 at offset 96 from the beginning of the IP header.

```
match/ds-filter/nortel/2.2.2.2# user-defined reference start-ip-header offset 96
bitwidth 16 range 0192
user-defined/filter/nortel/2.2.2.2/start-ip-header/96/16/0192# back
match/ds-filter/nortel/2.2.2.2# back
ds-filter/nortel/2.2.2.2# actions
actions/ds-filter/nortel/2.2.2.2# action drop
actions/ds-filter/nortel/2.2.2.2#
```

Specifying the Action of Traffic Filters

By default, the action of each differentiated services traffic filter is to accept the packet if it matches all the filter's match criteria. You can use the **mark** and **police** actions to change per-hop behavior of filtered traffic and to classify traffic for RED protocol prioritization in DSQMS.

To change the filtering actions, navigate to the actions prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; actions**) and specify one or more of the actions described in Table 3-4.

Table 3-4. Actions for DiffServ Traffic Filters

Action	Command Syntax	Description
accept	action accept	The router processes any packet that matches the filter criteria and ranges. This value is the default action.
drop	action drop	The router does not route any packet that matches the filter criteria and ranges.
mark	action mark <*dscp_octet*>	The router changes the DSCP (DS field) of any packet that matches the filter to the specified binary octet.
police	action police; police	Police actions are activated on the router and you enter the police context. You must specify policing parameters as described in Table 3-5.

Example - Mark Action

This example creates a filter that marks packets sent from IP address 192.168.44.5 with a new value in the DS field.

```
ds-filter/nortel/2.2.2.2# match
match/ds-filter/nortel/2.2.2.2# source-network 192.168.44.5
source-network/ds-filter/nortel/192.168.44.5# back
match/ds-filter/nortel/2.2.2.2# back
ds-filter/nortel/2.2.2.2# actions
actions/ds-filter/nortel/2.2.2.2# action mark mark-value 00111100
actions/ds-filter/nortel/2.2.2.2#
```

The mark value is a binary number. Because the last two bits of the DS field are currently unused, the last two bits for mark-value must be set to 0.

For information about how DSQMS uses the DS field, refer to "Configuring Queue Management and Scheduling" on page 2-7 and to RFC 2474, "Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers."

Specifying Police Parameters

If you add the police action to a filter, you must configure policing parameters in the police context. To set the policing actions, navigate to the police prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; actions; police**) and specify one or more of the parameters described in Table 3-5.

Table 3-5. DS Police Parameters

Parameter	Values	Function
inprofile-behavior	mark (default) no-change	Tells the router how to treat packets that are within the filter profile
inprofile-marking	00000000 (default) through 11111100	Specifies the value that the DS byte is set to if the policing algorithm accepts the packet. The value represents the type of service that the packet receives.
max-policed	0 through 4294967295 (default)	Specifies the maximum packet size that the router allows for the network. This parameter lets the router prevent large packets from being admitted into the network.
min-policed	0 through 4294967295 (default 20)	Specifies the minimum packet size that the router allows for the network. If the packet size is smaller than the value set for this parameter, the router uses this parameter value as the packet size.
outprofile-behavior	no-change (default) mark drop	Tells the router how to treat the packet if it does not fit the filter profile
outprofile-marking	00000000 (default) through 11111100	Tells the router how to mark the packet if the packet size does not fit the filter profile, for example, if the host is sending more data than it should

(continued)

Table 3-5. DS Police Parameters *(continued)*

Parameter	Values	Function
token-bucket-rate	0 (default) through 4294967295	Sets the rate at which the router accepts data. Specifying the data rate can prevent the host from sending too much data to the router.
token-bucket-size	0 (default) through 4294967295	Determines the burst size of the data that the router accepts. This parameter enables the router to guard against large bursts of data; it balances the flow of data.

Example - Police Action

This example increases the min-policed value to 40 and decreases the max-policed maximum packet size to 3000100100:

```
ds-filter/nortel/2.2.2.2# actions
actions/ds-filter/nortel/2.2.2.2# action police
actions/ds-filter/nortel/2.2.2.2# police
police/ds-filter/nortel/2.2.2.2# min-policed 40
police/ds-filter/nortel/2.2.2.2# max-policed 3000100100
police/ds-filter/nortel/2.2.2.2#
```

Specifying the Log Action

You can specify the log action in combination with other actions. By default, the system event log file is set to off. To log traffic filter events and to specify the level of detail that you want to include in the system event log, go to the actions prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel; actions**) and enter:

action-log {off | on | detailed}

off (the default) specifies that no differentiated services traffic filter information is written to the system event log file.

on indicates that when an incoming packet matches the criteria, the traffic filter adds an entry that contains limited traffic filter information to the system event log file.

detailed indicates that the traffic filter adds an entry that contains detailed differentiated services traffic filter information to the system event log file.

Disabling and Reenabling Traffic Filters

By default, traffic filters are enabled on a differentiated services interface. To disable or reenable a traffic filter on a differentiated services interface, go to the traffic filter prompt (for example, **box; ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv; traffic-filter nortel**) and enter:

state {disabled | enabled}

The following example shows how to disable and reenable a differentiated services traffic filter on an interface:

```
ds-filter/nortel/2.2.2.2# state disabled
ds-filter/nortel/2.2.2.2# state enabled
ds-filter/nortel/2.2.2.2#
```

Configuration Example

This example demonstrates the entire process of creating a differentiated services traffic filter on a differentiated services interface. The traffic filter drops HTTP traffic.

```
box# ethernet/2/1; ip/2.2.2.2/255.0.0.0; diffserv
diffserv/2.2.2.2# traffic-filter filter-name filter2
ds-filter/filter2/2.2.2.2# match
match/ds-filter/filter2/2.2.2.2# dest-tcp-ports 80
match/ds-filter/filter2/2.2.2.2# back
ds-filter/filter2/2.2.2.2# actions
actions/ds-filter/filter2/2.2.2.2# action drop
actions/ds-filter/filter2/2.2.2.2# back
ds-filter/filter2/2.2.2.2# info
   filter-name   filter2
   precedence    1
   state         enabled
ds-filter/filter2/2.2.2.2# back
diffserv/2.2.2.2#
```

Creating Static Filters Using Site Manager

When you create traffic filters using Site Manager, understand the difference between a traffic filter template and an actual traffic filter. A *filter template* is a reusable, predefined specification for a traffic filter. You create an actual *traffic filter* when you apply a filter template to a configured router interface. You can apply a single template to as many interfaces as you want.

Each template must contain filter criteria and filter actions (log, drop, accept, set DS field, set DS police). The actions are performed on the filtered packets.

Note: Log is the only action that you can combine with other actions. For example, you cannot combine Set DS Field and Set DS Police for one filter.

Creating a Filter Template

To configure a differentiated services filter template, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **IP**.	The IP menu opens.
3. Choose **DiffServ**.	The DiffServ menu opens.
4. Choose **Interfaces**.	The DiffServ Interface List window opens.
5. Select the interface that you want to modify and click on **Traffic Filt**.	The DiffServ Static Filters window opens.
6. Click on **Template**.	The Filter Template Management window opens.
7. Click on **Create**.	The Create DiffServ Template window opens.
8. Type a name for the template in the **Filter Name** field.	
9. Choose **Criteria**.	The Criteria menu opens.
10. Choose **Add**.	The Add menu opens.

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
11. Add one or more filter criteria.	
12. Choose **Action**.	The Action menu opens.
13. Choose **Add**.	The Add menu opens.
14. To select the DS field for the filter action, choose **DiffServ Set Field** and set a value for the DS field: 00000000 through 11111111. See “DS Field” on page A-18 for more information.	
15. To select the DiffServ Police for the filter action, choose **DiffServ Set Police** and set the following parameters: • **Token Bucket Rate (Kbps)** • **Token Bucket Size (Bits)** • **Inprofile Marking** • **Out of Profile Marking** Click on **Help** or see the parameter descriptions beginning on page A-20. Accept the default values for the other parameters.	
16. Click on **Save**.	You return to the Create DiffServ Template window.
17. Click on **OK.**	You return to the Filter Template Management window.
18. Click on **Done**.	You return to the DiffServ Static Filters window.
19. Apply the filter template according to the instructions in the next section.	

Applying the Template to a Filter

After you create your differentiated services filter template, you create a filter by applying the template to a differentiated services interface.

To apply a filter template, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the DiffServ Static Filters window, click on **Create**.	The Create Filter window opens.
2. Type a name for the filter in the **Filter Name** field.	
3. Select the differentiated services interface that will use this filter in the Interfaces list.	
4. Select a template in the Templates list.	
5. Click on **OK.**	You return to the DiffServ Static Filters window. Site Manager displays the filter name and its interface in the list.
6. Click on **Done** until you return to the Configuration Manager window.	

Configuring Filters for HTTP Packets

To modify a filter to include URLs, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. See "Creating a Filter Template" on page 3-17 and follow steps 1 through 5 in the table.	
2. Click on **Edit**.	The Edit DiffServ Filters window opens.
3. Choose **Criteria**.	The Criteria menu opens.
4. Choose **Add**.	The Add menu opens.
5. Choose **Add URL**.	The Add URL window opens.
6. Set the **URL** parameter. See the parameter description on page A-23.	
7. Click on **OK.**	You return to the Edit DiffServ Filters window.
8. Click on **OK**.	You return to the DiffServ Static Filters window.
9. Click on **Done** until you return to the Configuration Manager window.	

You must always associate filter criteria with a filter action. In this way, the router uses the URL criterion with the appropriate differentiated services action, for example, DiffServ Set Field, to determine how to mark packets.

Customizing the Action of Traffic Filters

These procedures assume that you created a filter template and applied it to a filter. To modify a filter that includes the DS Field or DS Police action, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **IP**.	The IP menu opens.
3. Choose **DiffServ**.	The DiffServ menu opens.
4. Choose **Interfaces**.	The DiffServ Interface List window opens.
5. Select the interface that you want to modify and click on **Traffic Filt**.	The DiffServ Static Filters window opens.
6. Select the filter that you want to edit and click on **Edit**.	The Edit DiffServ Filters window opens.
7. To change the DS field entry, choose **Action** > **Edit DS Field**.	The DS Field window opens.
8. To modify the DS Police action, choose **Action > Edit DS Police** and set the following parameters: • **Token Bucket Rate (Kbps)** • **Token Bucket Size (Bits)** • **Min Policed (Bytes)** • **Max Policed (Bytes)** • **Inprofile Marking** • **Inprofile Behavior** • **Out of Profile Marking** • **Out of Profile Behavior** Click on **Help** or see the parameter descriptions beginning on page A-20.	
9. Click on **Save.**	You return to the Edit DiffServ Filters window.
10. Click on **OK**.	You return to the DiffServ Static Filters window.
11. Click on **Done** until you return to the Configuration Manager window.	

Modifying URL Match Criteria

These procedures assume that you created a filter template and applied it to a filter. To modify a filter that includes a URL as a criterion, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **IP**.	The IP menu opens.
3. Choose **DiffServ**.	The DiffServ menu opens.
4. Choose **Interfaces**.	The DiffServ Interface List window opens.
5. Select the interface that you want to modify and click on **Traffic Filt**.	The DiffServ Static Filters window opens.
6. Select the filter that you want to edit and click on **Edit**.	The Edit DiffServ Filters window opens.
7. Select a URL and click on **Modify**.	The Edit URL window opens.
8. Make any modifications, then click on **OK**.	You return to the Edit DiffServ Filters window.
9. Click on **OK**.	You return to the DiffServ Static Filters window.
10. Click on **Done** until you return to the Configuration Manager window.	

Where to Go Next

After you complete the steps in this chapter, differentiated services traffic filters should be operating on at least one interface.

- To customize the differentiated services configuration, go to Chapter 4, “Customizing Differentiated Services.”
- To customize DSQMS, go to Chapter 6, “Customizing Queue Management and Scheduling.”

Chapter 4
Customizing Differentiated Services

When you enable differentiated services, default values are in effect for all parameters. Depending on your network requirements, you may want to change these values.

This chapter describes how to customize your differentiated services configuration and includes the following topics:

Topic	Page
Modifying a Differentiated Services Interface	4-2
Disabling and Reenabling Differentiated Services	4-4
Deleting a Differentiated Services Interface	4-6

Additional customization information is available:

- For information about customizing static traffic filters, refer to Chapter 3, "Configuring Static Traffic Filters for Differentiated Services."
- For information about customizing COPS, refer to Chapter 5, "Customizing COPS."
- For information about customizing queue management, refer to Chapter 6, "Customizing Queue Management and Scheduling."

Modifying a Differentiated Services Interface

You can modify the configuration type (static or COPS) of a differentiated services interface, specify which debug messages for an interface are stored in the router's event log, and specify an idle timer for URL filters.

For instructions on adding differentiated services to an IP interface, see "Starting Differentiated Services Using the BCC" on page 2-3 or "Starting Differentiated Services Using Site Manager" on page 2-5.

Note: If you want to change the configuration type from static to COPS, see "Enabling COPS" on page 2-4. If you want to change the configuration type from COPS to static, read the instructions in this section and then go to Chapter 3, "Configuring Static Traffic Filters for Differentiated Services."

Using the BCC

To modify a differentiated services interface:

1. **Navigate to the diffserv context on the IP interface (for example, box; serial/3/1; ip/2.2.2.2/255.0.0.0; diffserv).**

   ```
   ip/2.2.2.2/255.0.0.0# diffserv
   diffserv/2.2.2.2#
   ```

2. **Enter one or more of the following commands:**

   config-type {static | cops}
   debug-level {extra-debug | filter-maintenance | interaction-with-cops | ip-interaction | trigger-event}
   url-idleout-timer *<integer>*

   integer is the amount of time (in seconds) that the router waits before a dynamic URL filter on the next-hop interface is deleted.

   Refer to the parameter description for "Debug Log Mask (hex)" on page A-3 for a description of the debug-level parameters.

   For example, the following commands configure the router to send trigger messages to the event log and set the URL timeout to 240 seconds:

   ```
   diffserv/2.2.2.2# debug-level trigger-events
   diffserv/2.2.2.2# url-idleout-timer 240
   diffserv/2.2.2.2#
   ```

Using Site Manager

To modify a differentiated services interface, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **IP**.	The IP menu opens.
3. Choose **DiffServ**.	The DiffServ menu opens.
4. Choose **Interfaces**.	The DiffServ Interface List window opens.
5. Select the interface that you want to modify.	
6. Set the following parameters: • **Config Type** • **Debug Log Mask (hex)** • **URL Idle Out Timer** Click on **Help** or see the parameter descriptions beginning on page A-3.	
7. Click on **Done**.	You return to the Configuration Manager window.

Disabling and Reenabling Differentiated Services

After you create a differentiated services interface, by default it is enabled. You can disable and reenable a single interface or all interfaces at any time.

Using the BCC

To disable a single interface:

1. **Navigate to the diffserv prompt on the IP interface.**

```
ip/2.2.2.2/255.0.0.0# diffserv
diffserv/2.2.2.2#
```

2. **Enter the following command:**

```
diffserv/2.2.2.2# disable
diffserv/2.2.2.2#
```

To reenable differentiated services on an interface, enter the following command:

```
diffserv/2.2.2.2# enable
diffserv/2.2.2.2#
```

To globally disable differentiated services:

1. **Navigate to the global IP prompt (for example, box; ip).**
2. **Enter the following command:**

```
ip# disable diffserv
ip#
```

To globally reenable differentiated services, enter the following command:

```
ip# enable diffserv
ip#
```

Using Site Manager

To disable or reenable a single interface, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **IP**.	The IP menu opens.
3. Choose **DiffServ**.	The DiffServ menu opens.
4. Choose **Interfaces**.	The DiffServ Interface List window opens.
5. Select the interface that you want to disable or reenable.	
6. Set the **Enable** parameter. Click on **Help** or see the parameter description on page A-3.	
7. Click on **Done**.	You return to the Configuration Manager window.

To globally disable or reenable all differentiated services interfaces, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **IP**.	The IP menu opens.
3. Choose **DiffServ**.	The DiffServ menu opens.
4. Choose **Global**.	The Edit DiffServ Global Parameters window opens.
5. Set the **Enable** parameter. Click on **Help** or see the parameter description on page A-6.	
6. Click on **Done**.	You return to the Configuration Manager window.

Deleting a Differentiated Services Interface

You can delete differentiated services from a single interface or from all interfaces on the router.

Using the BCC

To delete differentiated services from a single interface:

1. **Navigate to the IP interface prompt (for example, box; ethernet/2/1; ip/2.2.2.2/255.0.0.0).**
2. **Check whether any filter on the interface has a "police" filter action by entering the following command:**

```
ip/2.2.2.2/255.0.0.0# show diffserv traffic-filter detail

Filter: pur
 Match:
  tcp-udp destination-ports:
   80-80
Action:
 action mark mark-value: 00111100

ip/2.2.2.2/255.0.0.0#
```

   For security reasons, you cannot delete differentiated services from an interface with a policing filter without removing the filter first. If you are certain that you no longer need to police the interface, delete the filter.

3. **Enter the following command:**

```
ip/2.2.2.2/255.0.0.0# delete diffserv/2.2.2.2
ip/2.2.2.2/255.0.0.0#
```

To globally delete differentiated services:

1. **Delete differentiated services from each IP interface where it is configured.**

   You cannot globally delete differentiated services using the BCC if any differentiated services interfaces exist.

2. **Navigate to the global IP prompt (for example, box; ip).**
3. **Enter the following command:**

```
ip# delete diffserv
ip#
```

Using Site Manager

To delete a single interface, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **IP**.	The IP menu opens.
3. Choose **DiffServ**.	The DiffServ menu opens.
4. Choose **Interfaces**.	The DiffServ Interface List window opens.
5. Select the interface that you want to delete, and click on **Delete**.	Site Manager removes the interface from the list.
6. Click on **Done**.	You return to the Configuration Manager window.

To globally delete differentiated services from all IP interfaces on which it is configured, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **IP**.	The IP menu opens.
3. Choose **DiffServ**.	The DiffServ menu opens.
4. Choose **Delete**.	A confirmation window prompts: `Do you REALLY want to delete DiffServ?`
5. Click on **OK**.	You return to the Configuration Manager window.

Chapter 5
Customizing COPS

When you start differentiated services with COPS for filter management, by default you set up a single policy server with default values (see Chapter 2, "Starting Differentiated Services"). You can add policy servers to the configuration, choose the priority order in which they are used, and change parameters such as the router's COPS client address.

This chapter describes how to customize your COPS configuration and includes the following topics:

Topic	Page
Modifying COPS Global Parameters	5-2
Adding COPS Servers	5-3
Prioritizing COPS Servers	5-4
Modifying the COPS Connection	5-5
Maintaining the TCP Connection to the Server	5-7
Changing the Remote TCP Port	5-9
Disabling and Reenabling a COPS Server	5-10
Deleting a COPS Server	5-11
Disabling and Reenabling COPS on the Router	5-12
Deleting COPS from the Router	5-13

Modifying COPS Global Parameters

In most cases, you do not need to modify the solo slot mask, the COPS client's IP address, or the client ID after you initially configure them. However, you can modify these parameters.

Using the BCC

To modify the client's address, ID, or solo slot mask:

1. **Navigate to the global COPS prompt (for example, box; cops).**
2. **Reset the address, ID, and solo slot mask as needed.**

```
cops# address 2.2.2.7
cops# id sparta
cops# solo-slot-mask {2 4 5}
cops#
```

Using Site Manager

To modify the client's address, ID, or slot mask, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Global**.	The Edit COPS Global Parameters window opens.
5. Set the following parameters: • **Solo Slot Mask** • **Client IP Address** • **Client ID** Click on **Help** or see the parameter descriptions beginning on page A-8.	
6. Click on **OK**.	You return to the Configuration Manager window.

Adding COPS Servers

You can add COPS servers to your router configuration to provide additional or backup filter information.

Using the BCC

To add COPS servers that the router can communicate with:

1. **Navigate to the global COPS prompt (for example, box; cops).**
2. **Configure a COPS server, providing the IP address of a policy server.**

```
cops# cops-server 192.1.1.4
cops-server/192.1.1.4# back
cops#
```

3. **Add as many servers as necessary.**

Using Site Manager

To add COPS servers that the router can communicate with, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Servers**.	The COPS Server List window opens.
5. Click on **Add**.	The COPS Server Record window opens.
6. Set the **IP Address** parameter. Click on **Help** or see the parameter description on page A-16.	
7. Click on **OK**.	You return to the COPS Server List window. Site Manager adds the new server to the server list.
8. Click on **Done**.	You return to the Configuration Manager window.

Prioritizing COPS Servers

By default, all COPS servers have a priority value of 1 and are utilized based on their IP address; the lowest address number is used first.

You can prioritize the available COPS servers so that the router attempts to connect to one server before trying another. The router can connect to only one server at a time. The server with the lowest configured integer gets first priority.

Using the BCC

To assign a priority to a COPS server:

1. **Navigate to the COPS server prompt (for example, box; cops; cops-server/192.1.1.1).**
2. **Set the priority parameter. You can enter an integer from 1 through 128.**

```
cops-server/192.1.1.1# priority 4
cops-server/192.1.1.1#
```

Using Site Manager

To assign a priority to a COPS server, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Servers**.	The COPS Server List window opens.
5. Select the COPS server whose priority you want to change.	
6. Set the **Priority** parameter. Click on **Help** or see the parameter description on page A-10.	
7. Click on **Apply**.	
8. Click on **Done**.	You return to the Configuration Manager window.

Modifying the COPS Connection

The connection to the COPS server is established at two different levels: the COPS layer and the TCP layer. The COPS application on the router is a TCP client.

At the COPS level, you can customize how the router connects to a COPS server, for example, by defining how often the router retries a connection and how long the router keeps the connection active.

Using the BCC

To customize how the router connects to a COPS server:

1. **Navigate to the COPS server that you want to modify (for example, box; cops; cops-server/192.1.1.1).**
2. **Set one or more of the parameters described in Table 5-1.**

Table 5-1. Customizable COPS Server Parameters

Parameter	Values	Function
connection-timer	1 through 65535 seconds (default 30)	Specifies the time between connection retry attempts to the server
keepalive-timer	1 through 65535 seconds (default 60)	Specifies the time between the transmission of keepalive packets to the server
priority	1 through 128 (default 1)	Assigns a priority to the COPS server. The lower the number, the higher the priority.
remote-port	1 through 65535 (default 3288)	Specifies the remote TCP port of the COPS server
report-timer	1 through 65535 seconds (default 360)	Specifies the time between the transmission of statistics reports to the server
retry-counter	1 through 10 (default 3)	Specifies the number of connection attempts that the router makes before determining that the server is unreachable
state	enabled (default) disabled	Enables or disables the COPS server

(continued)

Table 5-1. Customizable COPS Server Parameters *(continued)*

Parameter	Values	Function
tcp-keepalive-max-retry	0 through 65535 (default 4)	Specifies the number of unacknowledged keepalive packets retransmitted before the TCP session is terminated. If this value is set to 0, the router sends only one keepalive packet.
tcp-keepalive-timer	0 through 65535 seconds (default 60)	Specifies the time period between the transmission of keepalive packets that the router sends across a TCP connection
tcp-rto	0 through 65535 seconds (default 60)	Specifies the keepalive retransmit timeout (RTO) period. This is the interval during which the router sends unacknowledged keepalive packets. If the tcp-keepalive-timer is set to 0, the router ignores this timer.

For example, the following commands set the time between retries to 15 seconds, the time period between sending keepalive messages to 45 seconds, the time between reports to 480 seconds (8 minutes), and the number of retries to 5:

```
cops-server/192.1.1.1# connection-timer 15
cops-server/192.1.1.1# keepalive-timer 45
cops-server/192.1.1.1# report-timer 480
cops-server/192.1.1.1# retry-counter 5
cops-server/192.1.1.1#
```

Using Site Manager

To customize how the router connects to a COPS server, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Servers**.	The COPS Server List window opens.
5. Select the server that you want to modify.	

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
6. Set the following parameters: • **Connection Retry Period** • **Connection Retry Count** • **KeepAlive Time Period** • **Report Time Period** Click on **Help** or see the parameter descriptions beginning on page A-10.	
7. Click on **Apply**.	
8. Click on **Done**.	You return to the Configuration Manager window.

Maintaining the TCP Connection to the Server

The router communicates with the COPS server across a TCP connection. To keep the connection established, even when there is no data being transmitted, you can configure keepalive timers and retry counts to maintain the connection.

Using the BCC

To modify the keepalive parameters that maintain the TCP connection:

1. **Navigate to the COPS server that you want to modify (for example, box; cops; cops-server/192.1.1.1).**
2. **Set one or more of the TCP parameters described in Table 5-1.**

For example, the following commands set the maximum number of retries for unacknowledged keepalive messages to 10, the time period between keepalive messages to 90 seconds, and the keepalive retransmit timeout period to 90 seconds:

```
cops-server/192.1.1.1# tcp-keepalive-max-retry 10
cops-server/192.1.1.1# tcp-keepalive-timer 90
cops-server/192.1.1.1# tcp-rto 90
cops-server/192.1.1.1#
```

Using Site Manager

To modify the keepalive parameters that maintain the TCP connection, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Servers**.	The COPS Server List window opens.
5. Select the server that you want to modify.	
6. Set the following parameters: • **TCP KeepAlive Interval** • **TCP KeepAlive RTO** • **TCP KeepAlive Max Retry Cnt** Click on **Help** or see the parameter descriptions beginning on page A-12.	
7. Click on **Apply**.	
8. Click on **Done**.	You return to the Configuration Manager window.

Changing the Remote TCP Port

If the policy server application operates on a different TCP port than the default port, 3288 (the defined COPS standard), you can specify a different port. In most cases, however, you can use the default port.

Using the BCC

To modify the remote TCP port:

1. **Navigate to the COPS server that you want to modify (for example, box; cops; cops-server/192.1.1.1).**
2. **Set the remote port number.**

```
cops-server/192.1.1.1# remote-port 3290
cops-server/192.1.1.1#
```

Using Site Manager

To modify the remote TCP port, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Servers**.	The COPS Server List window opens.
5. Select the server that you want to modify.	
6. Set the **Remote TCP Port** parameter. Click on **Help** or see the parameter description on page A-14.	
7. Click on **Apply**.	
8. Click on **Done**.	You return to the Configuration Manager window.

Disabling and Reenabling a COPS Server

You can temporarily disable and then reenable a COPS server.

Using the BCC

To disable a COPS server:

1. **Navigate to the COPS server that you want to disable (for example, box; cops; cops-server/192.1.1.1).**
2. **Disable the server.**

```
cops-server/192.1.1.1# state disabled
cops-server/192.1.1.1#
```

To reenable a COPS server:

1. **Navigate to the COPS server that you want to reenable.**
2. **Reenable the COPS server.**

```
cops-server/192.1.1.1# state enabled
cops-server/192.1.1.1#
```

Using Site Manager

To disable and reenable a COPS server, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Servers**.	The COPS Server List window opens.
5. Select the server that you want to disable or reenable.	
6. Set the **Enable** parameter. Click on **Help** or see the parameter description on page A-10.	
7. Click on **Done**.	You return to the Configuration Manager window.

Deleting a COPS Server

You can delete a COPS server that should no longer be used or that is no longer available.

Using the BCC

To delete a COPS server:

1. **Navigate to the global COPS prompt (for example, box; cops).**
2. **Delete the COPS server, specifying its IP address.**

```
cops# delete cops-server/192.1.1.1
cops#
```

Using Site Manager

To delete a COPS server from the server list, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Servers**.	The COPS Server List window opens.
5. Select the server that you want to delete, then click on **Delete**.	Site Manager removes the entry.
6. Click on **Done**.	You return to the Configuration Manager window.

Disabling and Reenabling COPS on the Router

You can temporarily disable and then reenable COPS on the router.

Using the BCC

To disable COPS on all interfaces:

1. **Navigate to the top-level box or stack prompt.**
2. **Disable COPS.**

```
box# disable cops
box#
```

To reenable COPS on all interfaces:

1. **Navigate to the box or stack prompt.**
2. **Reenable COPS.**

```
box# enable cops
box#
```

Using Site Manager

To disable and reenable COPS on the router, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Global**.	The Edit COPS Global Parameters window opens.
5. Set the **Enable** parameter. Click on **Help** or see the parameter description on page A-7.	
6. Click on **OK**.	You return to the Configuration Manager window.

Deleting COPS from the Router

You can delete COPS from the router completely if you no longer plan to use policy servers.

Using the BCC

To delete COPS from the router:

1. **Navigate to the top-level box or stack prompt.**
2. **Delete COPS.**

```
box# delete cops
box#
```

Using Site Manager

To delete COPS from the router, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **Global Protocols**.	The Global Protocols menu opens.
3. Choose **COPS Client**.	The COPS Client menu opens.
4. Choose **COPS Delete**.	A confirmation window prompts: `Do you REALLY want to delete COPS?`
5. Click on **OK**.	You return to the Configuration Manager window.

Chapter 6
Customizing Queue Management and Scheduling

You can customize many aspects of how differentiated services queue management and scheduling (DSQMS) handles packets to optimize performance. Use the BCC configuration tool to customize RED and DSQMS.

This chapter describes how to customize DSQMS and includes the following topics:

Topic	Page
Modifying RED Parameters	6-2
Activating DSQMS Configuration Changes on an Interface	6-3
Configuring DSQMS to Dequeue Packets at Line Rate	6-3
Modifying the DSQMS Debug Level on an Interface	6-4
Modifying a DSQMS Queue	6-5
Changing a DSQMS Classifier's RED Function	6-8
Disabling DSQMS on an Interface	6-8
Disabling a Single DSQMS Queue	6-9
Deleting Unused dsqms-red Entries	6-9

Modifying RED Parameters

After you activate RED on the router, you configure different ways that RED functions through multiple instances of **dsqms-red**. The DSQMS traffic classifiers in queues use these various configurations of RED.

Table 6-1 lists RED parameters that can be configured under **dsqms-red**, their values, and functions.

Table 6-1. dsqms-red Object Parameters

Parameter	Values	Function
id	integer	Identifies the RED function. You cannot change this parameter.
min-threshold	integer 0 through 100 (default 20)	Indicates the queue size below which no packets are dropped by RED
max-threshold	integer 1 through 100 (default 80)	Indicates the queue size above which all packets are dropped by RED
first-order-const	integer 0 through 100 (default 1)	Specifies the first order constant used when calculating drop probability based on the average queue fraction, the queue size, and the min-threshold value
second-order-const	integer 0 through 1000 (default 10)	Specifies the second order constant used when calculating drop probability based on the average queue fraction, the queue size, and the min-threshold value

To modify an instance of dsqms-red:

1. **Navigate to the dsqms-red instance.**

```
box# red
red# dsqms-red 2
dsqms-red/2#
```

2. **Change the parameters as desired.**

```
dsqms-red/2# min-threshold 20
dsqms-red/2# max-threshold 85
dsqms-red/2#
```

You cannot change the **id** parameter.

Activating DSQMS Configuration Changes on an Interface

If you change parameters for the **dsqms**, **dsqms-queue**, or **dsqms-classifier** objects, you must restart DSQMS on the interface for the changes to take effect.

To restart DSQMS, go to the DSQMS prompt on the interface (for example, enter **box; serial/2/1; dsqms**) and enter:

restart set

This command causes an immediate update of the MIB entry for DSQMS on the interface. After you restart DSQMS, the **restart** parameter reverts almost instantly to its default value (**notset**).

For example, the following commands restart DSQMS and display DSQMS interface parameters. The **restart** parameter is reset to **notset**:

```
dsqms-queue/1/serial/2/1# back
dsqms/serial/2/1# restart set
dsqms/serial/2/1# info
  debug-level none
  dequeue-at-line-rate disabled
  restart notset
  state enabled
```

Configuring DSQMS to Dequeue Packets at Line Rate

If you configure both weighted and priority queues on an interface, you may experience latency problems with the high-priority queues. To reduce delay for queues that need a constant delay rate when limited bandwidth is available, enable the DSQMS interface parameter **dequeue-at-line-rate**.

This parameter controls the dequeuing of packets from the queues to the driver. It guarantees constant bandwidth for traffic that requires a constant delay rate when there are more buffers than the line can accommodate.

Note: For other guidelines to optimize DSQMS performance, see "Implementation Notes" on page 2-9.

To enable or disable the **dequeue-at-line-rate** parameter, go to the DSQMS prompt on the interface (for example, **box; serial/2/1; dsqms**) and enter:

dequeue-at-line-rate {**enabled** | **disabled**}

For example, the following commands enable the interface to dequeue packets at line rate:

```
box# serial/2/1; dsqms
dsqms/serial/2/1# dequeue-at-line-rate enabled
dsqms/serial/2/1# restart set
dsqms/serial/2/1#
```

Modifying the DSQMS Debug Level on an Interface

By default, the router does not log messages generated by DSQMS. To troubleshoot a problem, you can configure the router to log DSQMS event messages for an interface by specifying trace or detailed for the debug-level parameter.

To configure DSQMS event message logging, go to the DSQMS prompt on the interface (for example, **box; serial/2/1; dsqms**) and enter:

debug-level {**trace** | **detailed**}

trace logs related DSQMS function names.

detailed logs trace messages, some environment variables, and queue information.

To disable event message logging, set the **debug-level** parameter to **none** (the default value).

Note: For more information about any event message, see the event database on the documentation CD.

For example, the following commands modify the debug level to log as much information as possible, and activate the change immediately:

```
dsqms/serial/2/1# debug-level detailed
dsqms/serial/2/1# restart set
dsqms/serial/2/1#
```

Modifying a DSQMS Queue

Table 6-2 lists the parameters that you can set to customize a differentiated services queue on an interface.

Table 6-2. Customizable DSQMS Queue Parameters

Parameter	Values	Function
average-queue-gain	percentage (default 30)	Specifies the percentage of buffer capacity that must fill for 1 second or more for DSQMS to compute a larger average queue size for use by RED
best-effort	no (default) yes	Specifies whether to use this queue for best-effort traffic. By default, DSQMS selects the weighted queue with the lowest configured weight as the best-effort queue; if all weighted queues have the same weight, the last one created becomes the best-effort queue. If priority queues only are configured on the interface, DSQMS selects the queue with the lowest priority; if all queues have the same priority, the last one created becomes the best-effort queue. Use this parameter to override the default selection and select a different best-effort queue.
byte-limit	integer (default 0)	Indicates the maximum number of bytes that this queue can hold. The value 0 indicates that this queue is limited only by global memory.
cfg-pkt-limit	integer (default 0)	Indicates the maximum number of packets that this queue can hold. The value 0 indicates that this queue is limited only by global memory.
cfg-weight	integer 1 through 100 (default 1)	Indicates the ratio of this queue to the sum of all weighted queues on the interface. Can be calculated relative to other queue values or expressed as a percentage, provided that all weighted queues add up to 100. Applicable to weighted queues only.
drop-type	tail-drop (default) red	Indicates whether RED is used for active queue management
flow-fairness	disabled (default) enabled	Indicates whether a hash table is used to separate data packets into buckets within this queue. This mechanism improves fairness within a queue.
idle-queue-loss-rate	percentage (1 through 99) (default 30)	Specifies the percentage of buffer capacity that must empty for 1 second or more for DSQMS to compute a smaller average queue size for use by RED
jitter-const	small normal (default) large	Categorizes how sensitive traffic in this queue is to the jitter effect, and thus provides an indicator for calculating the bucket size in flow fairness. Reset this parameter if the packets that this queue will handle are small (for example, VoIP packets) or large (for example, video packets).

(continued)

Table 6-2. Customizable DSQMS Queue Parameters *(continued)*

Parameter	Values	Function
priority-level	integer 0 through 29 (default 0)	Sets the priority level for this queue; 0 is the highest priority. Applicable to priority queues only.
priority-time-quantum	integer 0 through 5000 (default 100)	Indicates the maximum amount of time (in milliseconds) that the queue is allowed to transmit data. Applicable to priority queues only.
state	disabled (default) enabled	Indicates whether the queue is functioning or not
type	priority (default) weighted	Selects the queue scheduling type: strict priority or weighted deficit round robin (DRR)

You cannot change the **id** parameter of an existing DSQMS queue. To make this change, you must create a new queue.

To modify a DSQMS queue:

1. **Navigate to the specific DSQMS queue on an interface.**

```
box# serial/2/1; dsqms;  dsqms-queue 1
dsqms-queue/1/serial/2/1#
```

2. **Use the info command to display the current values for this queue.**

```
dsqms-queue/1/serial/2/1# info
  average-queue-gain 30
  best-effort no
  byte-limit 0
  cfg-pkt-limit 0
  cfg-weight 1
  drop-type tail-drop
  flow-fairness disabled
  id 1
  idle-queue-loss-rate 30
  jitter-const normal
  priority-level 0
  priority-time-quantum 100
  state enabled
  type priority
dsqms-queue/1/serial/2/1#
```

Note that the BCC displays all parameters whether they are applicable to the queue type (priority or weighted) or not. If a parameter is not applicable, the **info** command displays its default value and the parameter cannot be changed.

Table 6-3 lists the DSQMS queue parameters that you can change for each queue type.

Table 6-3. Configurable DSQMS Queue Parameters by Queue Type

Parameter	Priority	Weighted
average-queue-gain	x	x
best-effort	x	x
byte-limit	x	x
cfg-pkt-limit	x	x
cfg-weight		x
drop-type	x	x
flow-fairness	x	x
idle-queue-loss-rate	x	x
jitter-const	x	x
priority-level	x	
priority-time-quantum	x	
state	x	x

3. **Change the parameters as required.**

```
dsqms-queue/1/serial/2/1# flow-fairness enabled
dsqms-queue/1/serial/2/1# jitter-const large
dsqms-queue/1/serial/2/1# back
dsqms/serial/2/1# restart set
dsqms/serial/2/1#
```

Changing a DSQMS Classifier's RED Function

A DSQMS classifier examines the differentiated services code point (DSCP) in the packet headers of traffic in a queue and directs the traffic to a particular instance of RED.

The **red-id** parameter of a **dsqms-classifier** object indicates the RED instance to be used for packets whose DSCPs match the classifier's configured DSCP. A value of 0 means that RED is not applicable to traffic that matches this classifier's DSCP. To understand the relationship between queues, classifiers, and RED instances, see Figure 2-2 on page 2-8.

To modify a DSQMS classifier:

1. **Navigate to the dsqms-classifier object that you want to change on a DSQMS queue.**

```
box# serial/2/1; dsqms; dsqms-queue 1
dsqms-queue/1/serial/2/1# dsqms-classifier 00001100
dsqms-classifier/00001100/serial/2/1#
```

2. **Change the red-id parameter as needed.**

```
dsqms-classifier/00001100/serial/2/1# red-id 3
dsqms-classifier/00001100/serial/2/1# back
dsqms-queue/1/serial/2/1# back
dsqms/serial/2/1# restart set
dsqms/serial/2/1#
```

You cannot change the **dscp** or **queue-id** parameters for an existing DSQMS classifier. To make these changes, you must create a new classifier.

Disabling DSQMS on an Interface

To disable DSQMS on an interface, navigate to the DSQMS interface prompt (for example, **box; serial/2/1; dsqms**) and enter the following command:

state disabled

For example, the following command disables DSQMS on serial interface 2/1:

```
dsqms/serial/2/1# state disabled
dsqms/serial/2/1# restart set
dsqms/serial/2/1#
```

Disabling a Single DSQMS Queue

To disable a single DSQMS queue, navigate to the queue prompt on the interface (for example, **box; serial/2/1; dsqms; dsqms-queue 1**) and enter the following command:

state disabled

For example, the following command disables DSQMS on queue 1 on serial interface 2/1:

```
dsqms-queue/1/serial/2/1# state disabled
dsqms-queue/1/serial/2/1# back
dsqms/serial/2/1# restart set
dsqms/serial/2/1#
```

Deleting Unused dsqms-red Entries

To stop using a particular dsqms-red instance, remove references to it from all traffic classifiers. Although it is not necessary, you can delete unused dsqms-red instances or RED for DSQMS completely. Deleting RED is not generally recommended.

If you plan to delete an unused dsqms-red instance, make sure that it is no longer in use by entering the **show dsqms classifiers** command at any BCC prompt.

To delete a dsqms-red instance, navigate to the RED prompt and enter the following command, specifying the appropriate dsqms-red instance ID:

```
box# red
red# delete dsqms-red/3
red#
```

To delete RED, enter the following command:

```
box# delete red
box#
```

All dsqms-red instances are deleted automatically.

Appendix A
Site Manager Parameters

This appendix contains the Site Manager parameter descriptions for differentiated services. You can display the same information using Site Manager online Help.

This appendix contains the following information:

Topic	Page
Interface List Parameters	A-2
Interface Record Parameter	A-5
Differentiated Services Global Parameter	A-6
COPS Global Parameters	A-7
COPS Server List Parameters	A-9
COPS Server Record Parameters	A-15
Static Traffic Filter Parameters	A-16

For each parameter, this appendix provides the following information:

- Parameter name
- Configuration Manager menu path
- Default setting
- Valid parameter options
- Parameter function
- Instructions for setting the parameter
- Management information base (MIB) object ID

The Technician Interface allows you to modify attributes by issuing **set** and **commit** commands with the MIB object ID. This process is equivalent to modifying parameters using Site Manager. For more information about using the Technician Interface to access the MIB, see *Using Technician Interface Software*.

Caution: The Technician Interface does not verify the validity of your parameter values. Entering an invalid value can corrupt your configuration.

Interface List Parameters

The DiffServ Interface List window (Figure A-1) contains the parameters for the differentiated services interfaces. These parameters let you enable an interface and determine its configuration type.

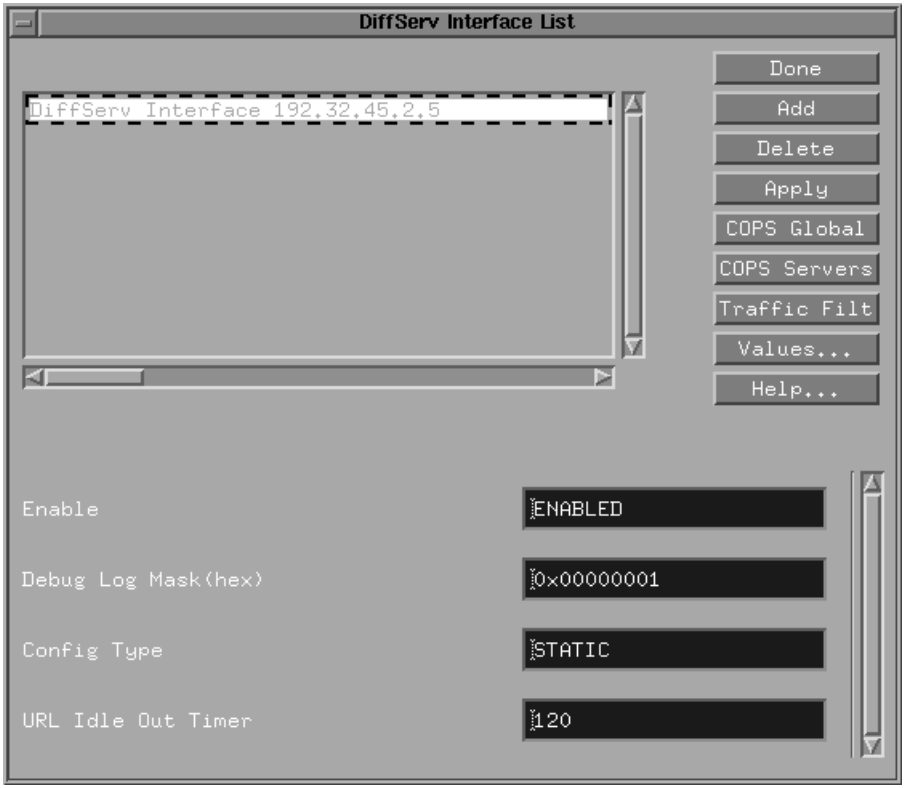


Figure A-1. DiffServ Interface List Window

Parameter: Enable

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces

Default: Enabled

Options: Enabled | Disabled

Function: Enables or disables differentiated services on this interface.

Instructions: After you configure a differentiated services interface, this parameter is enabled by default. To disable differentiated services on this interface without deleting it, select Disabled.

MIB Object ID: 1.3.6.1.4.1.18.3.5.26.2.1.2

Parameter: Debug Log Mask (hex)

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces

Default: 0x00000001

Options: Filter Maintenance | Interaction with COPS | Trigger Events | IP Interaction | Extra Debugging

Function: Specifies which event messages the router should include in the event log.

Instructions: Click on Values and select one or more types of event messages that you want to include in the log. To log events such as when a filter is added, deleted, enabled, or disabled, select Filter Maintenance. To log when a packet matches a trigger filter criterion and is sent to the server, select Trigger Events. The other options are for debugging. Site Manager fills in the appropriate hex value for the options that you choose.

MIB Object ID: 1.3.6.1.4.1.18.3.5.26.2.1.6

Parameter: Config Type

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces

Default: Static

Options: Static | COPS

Function: Indicates the configuration type for this interface. The configuration type specifies whether the interface uses manually configured filters or filters installed by the policy server.

Instructions: Select the appropriate configuration type:

Static — Select this option to manually configure filters. These filters identify packets for specific data flows and define the actions performed on each packet.

COPS — Select this option to use the Common Open Policy Service (COPS) protocol to request flow filters from the policy server. Using COPS, the flow filters are already available from the policy server and are downloaded to the router upon request.

MIB Object ID: 1.3.6.1.4.1.18.3.5.26.2.1.7

Parameter: URL Idle Out Timer

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces

Default: 120

Options: 1 to 0x7fffffff seconds

Function: Specifies the number of seconds that the router waits before a dynamic URL filter on the next-hop interface is deleted.

Instructions: Specify a value for the idle out time period.

MIB Object ID: 1.3.6.1.4.1.18.3.5.26.2.1.8

Interface Record Parameter

The DiffServ Interface Record window (Figure A-2) contains the IP Address parameter for the differentiated services interface. This parameter lets you specify a configured IP address as a differentiated services interface.

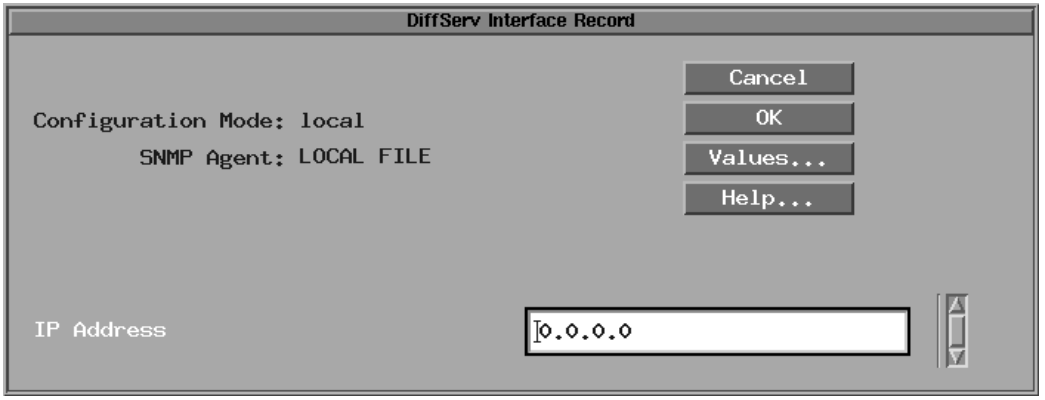


Figure A-2. DiffServ Interface Record Window

Parameter: IP Address

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Add**

Default: None

Options: An existing IP address on the router

Function: Identifies a differentiated services interface on the router.

Instructions: Enter the IP address of the differentiated services interface.

MIB Object ID: Not Applicable

Differentiated Services Global Parameter

The Edit DiffServ Global Parameters window (Figure A-3) contains the Enable parameter, which lets you disable and reenable all differentiated service interfaces on the router.

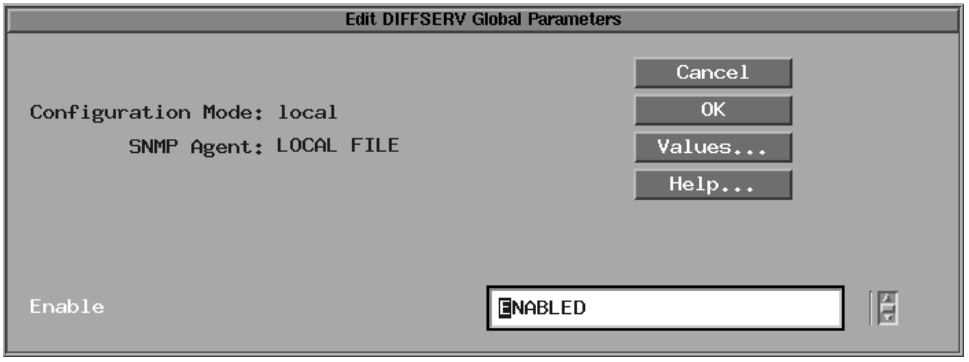


Figure A-3. Edit DiffServ Global Parameters Window

Parameter: Enable

Path: Configuration Manager > Protocols > IP > DiffServ > Global

Default: Enabled

Options: Enabled | Disabled

Function: Disables and reenables all differentiated services interfaces on the router.

Instructions: To disable differentiated services on the router, select Disabled. Otherwise, accept the default.

MIB Object ID: 1.3.6.1.4.1.18.3.5.26.1.2

COPS Global Parameters

The Edit COPS Global Parameters window (Figure A-4) contains the COPS client parameters. These global parameters apply to the entire router, not to an individual interface. These parameters let you customize how the router communicates with the policy server.

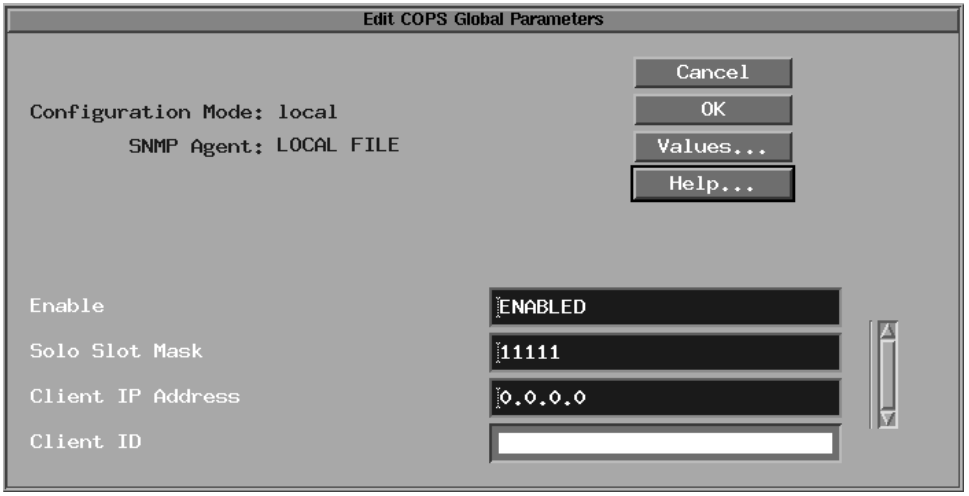


Figure A-4. Edit COPS Global Parameters Window

Parameter: Enable

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Global

Default: Enabled

Options: Enabled | Disabled

Function: Enables and disables COPS on the router.

Instructions: If you selected COPS as the configuration type, this parameter is automatically set to Enabled. To disable COPS without deleting it, select Disabled.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.1.2

Parameter: Solo Slot Mask

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Global

Default: All slots on the router. The number of slots varies by hardware platform.

Options: Hex number representing the slots on the router, up to slot 14.

Function: Specifies the mask for the slot on which the soloist can operate. The most significant bit (MSB) represents slot 1, the next most significant bit represents slot 2 and so on, up to slot 14.

Instructions: In most cases, accept the default. If you want to change how the router manages its slot resources, change the slot mask by clicking on Values and specifying the slots for the COPS soloist.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.1.6

Parameter: Client IP Address

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Global

Default: None

Options: An IP address of a router interface

Function: Specifies the IP interface address of the COPS client, that is, the router. COPS uses this address to communicate with the policy server.

Instructions: Enter the IP address on the router that acts as the COPS client.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.1.8

Parameter: Client ID

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Global

Default: None

Options: Any alphanumeric string

Function: Identifies the router to the COPS server by assigning it a unique ID.

Instructions: Specify an ID for the router as the COPS client.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.1.9

COPS Server List Parameters

The COPS Server List window (Figure A-5) contains the list of COPS servers that are allowed to install filters on the router.

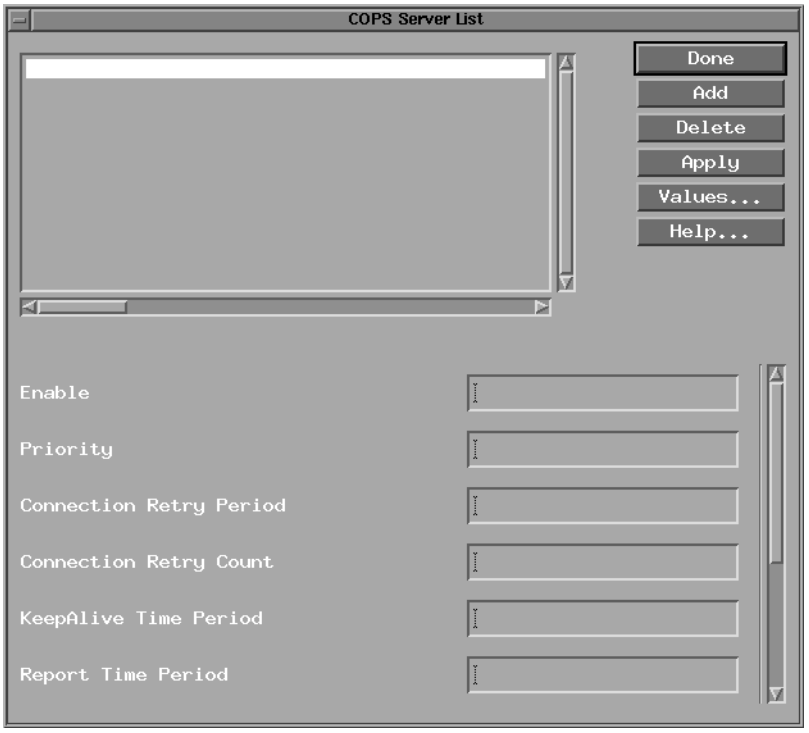


Figure A-5. COPS Server List Window

Parameter: Enable

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers

Default: Enabled

Options: Enabled | Disabled

Function: Enables and disables a COPS server.

Instructions: If you selected COPS as the configuration type, this parameter is automatically set to Enabled. To disable a COPS server without deleting it from the server list, select Disabled.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.2.1.2

Parameter: Priority

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers

Default: 1

Options: 1 to 128

Function: Assigns a priority rating to the COPS server. The lower the number, the higher the priority. For example, a server with a priority of 2 will be the active server before a server with a priority of 3.

Instructions: Enter a priority value for the server.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.2.1.4

Parameter: Connection Retry Period

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers

Default: 30

Options: 1 to 65535 seconds

Function: Specifies the time period, in seconds, between connection retry attempts to the server.

Instructions: Enter a value for the connection retry interval.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.2.1.6

Parameter:	**Connection Retry Count**
Path:	Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers
Default:	3
Options:	1 to 10
Function:	Specifies the number of connection attempts that the router makes before determining that the server is unreachable.
Instructions:	Enter a value for the number of connection retry attempts to the server.
MIB Object ID:	1.3.6.1.4.1.18.3.5.25.1.2.1.7

Parameter:	**KeepAlive Time Period**
Path:	Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers
Default:	60
Options:	1 to 65535 seconds
Function:	Specifies the time period, in seconds, between the transmission of keepalive packets to the server.
Instructions:	Enter a value for the transmission interval between keepalive packets. Note that the router negotiates this value with the server. If the server replies with a value that is different from the value you set, the router uses the server's value.
MIB Object ID:	1.3.6.1.4.1.18.3.5.25.1.2.1.8

Parameter: Report Time Period

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers

Default: 360

Options: 1 to 65535 seconds

Function: Specifies the time period, in seconds, between the transmission of statistics reports to the server. The statistics reports provide information for each flow filter.

Instructions: Enter a value for the transmission interval between reports. Note that the router negotiates this value with the server. If the server replies with a value that is different from the value you set, the router uses the server's value.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.2.1.9

Parameter: TCP KeepAlive Interval

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers

Default: 60

Options: 0 to 65535 seconds

Function: Specifies the time period, in seconds, between the transmission of keepalive packets that the router sends across a TCP connection.

Instructions: Enter a value for the transmission interval between TCP keepalive packets. Enter a value of 0 to disable this feature.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.2.1.10

Parameter: TCP KeepAlive RTO

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers

Default: 60

Options: 0 to 65535 seconds

Function: Specifies the keepalive retransmit timeout (RTO) period, in seconds. This is the interval during which the router sends unacknowledged keepalive packets. If the TCP KeepAlive Interval parameter is set to 0, the router ignores this timer.

If the TCP KeepAlive Interval Timer is set to a nonzero value and this parameter is set to 0, the router does not send keepalive packets. Either side of the connection can then end the session after the TCP KeepAlive Interval expires.

Instructions: Enter a value for the retransmit timeout period.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.2.1.11

Parameter: TCP KeepAlive Max Retry Cnt

Path: Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers

Default: 4

Options: 0 to 65535

Function: Specifies the number of unacknowledged keepalive packets retransmitted before the TCP session is terminated. If this value is set to 0, the router sends only one keepalive packet.

Instructions: Enter a number for the maximum number of unacknowledged keepalive packets that the router should send.

MIB Object ID: 1.3.6.1.4.1.18.3.5.25.1.2.1.12

Parameter:	**Remote TCP Port**
Path:	Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers
Default:	3288
Options:	1 to 65535
Function:	Specifies the remote TCP port of the COPS server.
Instructions:	In most cases, accept the default TCP port, 3288. If the policy server application operates on a port that is different from the default, specify a different port number.
MIB Object ID:	1.3.6.1.4.1.18.3.5.25.1.2.1.13

COPS Server Record Parameters

The COPS Server Record window (Figure A-6) contains the parameters that tell the router how to communicate with the COPS servers. With the exception of the IP Address parameter, described on page A-16, the parameters in this window are the same as those in the COPS Server List window (see Figure A-5 on page A-9).

See "COPS Server List Parameters" beginning on page A-9 for parameter descriptions.

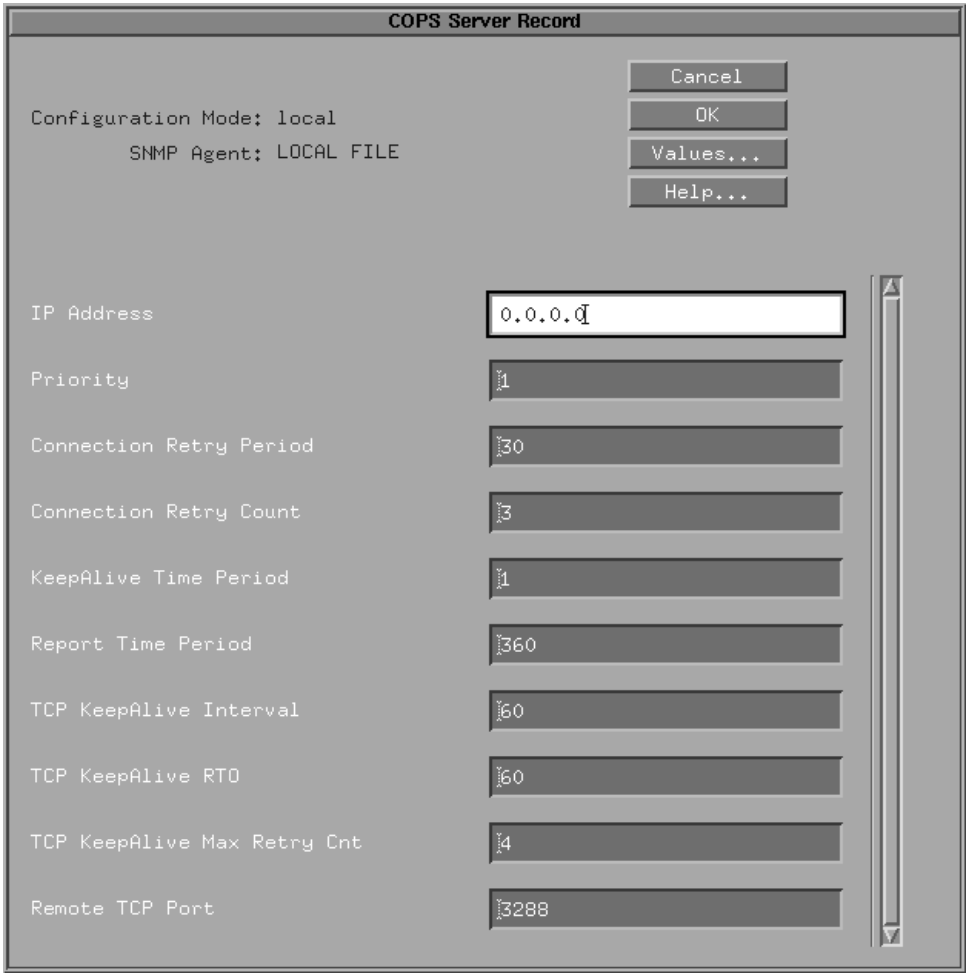


Figure A-6. COPS Server Record Window

Parameter:	**IP Address**
Path:	Configuration Manager > Protocols > Global Protocols > COPS Client > COPS Servers > **Add**
Default:	None
Options:	A valid IP address
Function:	Identifies the COPS server.
Instructions:	Enter the IP address of the COPS server.
MIB Object ID:	Not applicable

Static Traffic Filter Parameters

When you click on the Traffic Filt button in the DiffServ Interface List window (see Figure A-1 on page A-2), the DiffServ Static Filters window opens (Figure A-7). From this window, you can configure traffic filters.

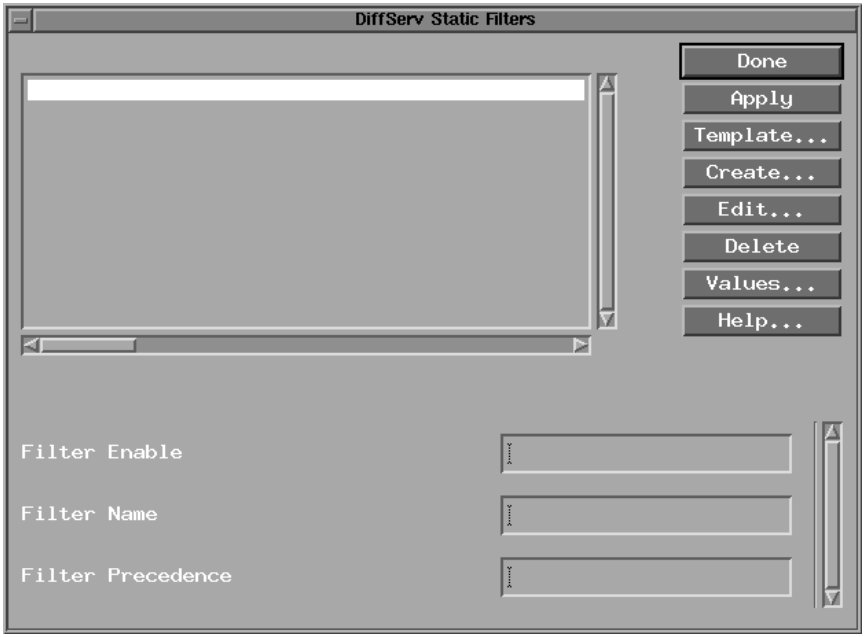


Figure A-7. DiffServ Static Filters Window

When you click on Template in the DiffServ Static Filters window (Figure A-7), and then click on Create, the Create DiffServ Template window opens (Figure A-8).

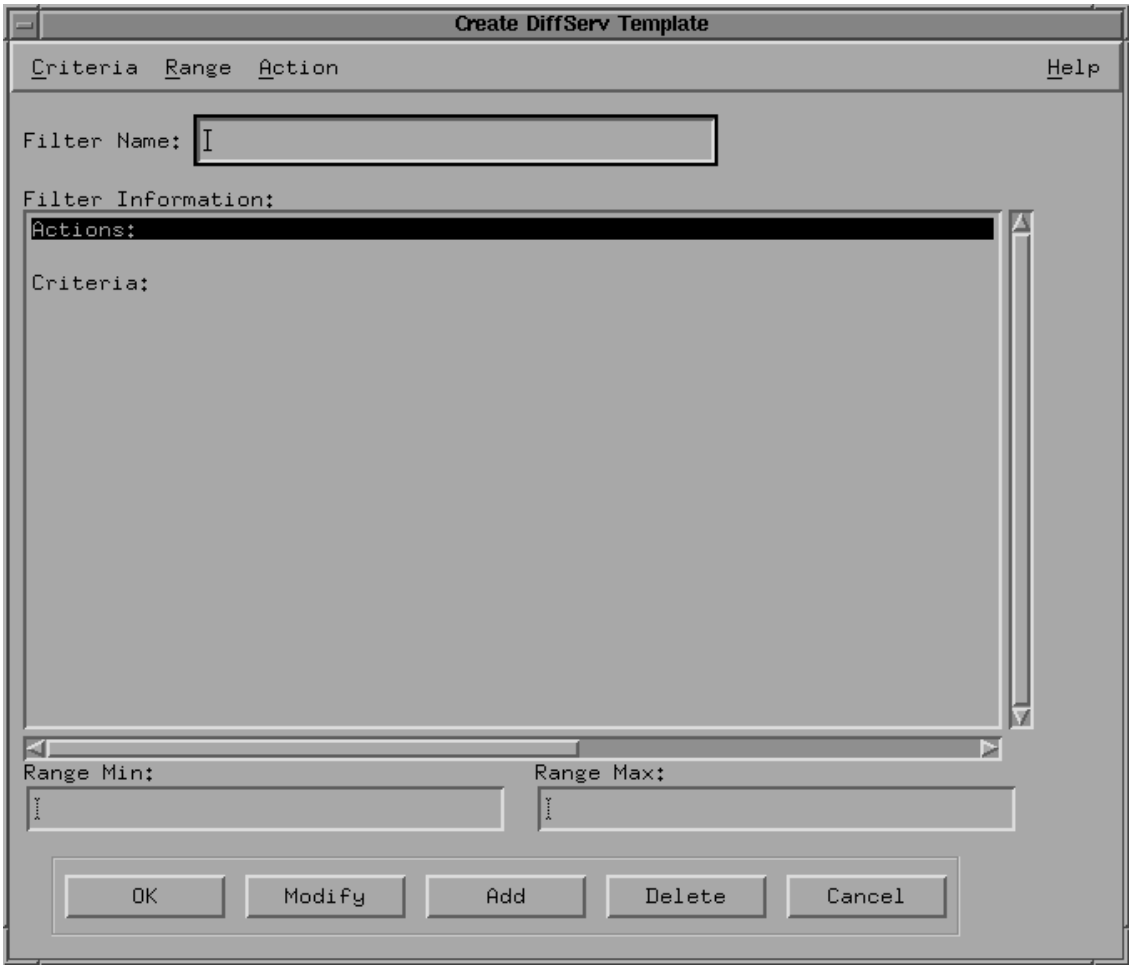


Figure A-8. Create DiffServ Template Window

From this window, you can configure filter criteria and actions.

There are many criteria that you can add to a filter. For more information about filters, see Chapter 3, "Configuring Static Traffic Filters for Differentiated Services."

The URL string criterion is unique to differentiated services.

For the filter criteria, you can add the following actions:

- Log
- Drop
- Accept
- DiffServ Set Field
- DiffServ Set Police

Note: Log is the only action that you can combine with other actions. For example, you cannot combine Drop and DiffServ Set Field.

DS Field

If you add the action DiffServ Set Field, the DS Field window opens (Figure A-9). The DS field specifies the marking of the DS field in the IP packet header. The value can be from 00000000 through 11111111, that is, from 0 through 255 expressed in binary form.

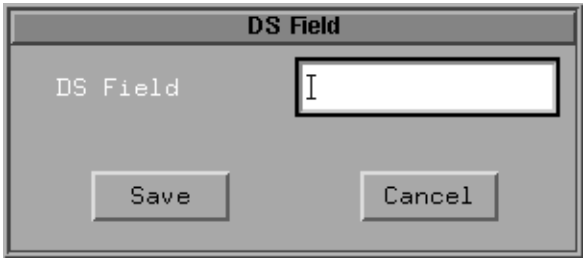


Figure A-9. DS Field Window

RFC 2474 defines specific guidelines for configuring the DS field. Six bits of the DS field are used to select the per-hop behavior of a packet as it travels through each node. The last two bits of the field are currently unused. The value of these two bits is ignored by differentiated services-compliant nodes when determining the per-hop behavior to apply to a packet.

DS Police Parameters

To configure static traffic filters that "police" the data flow, set the DS Police action for the filter and then configure the parameters in the DS Police window (Figure A-10).

Figure A-10. DS Police Window

Parameter: Token Bucket Rate (Kbps)

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Action > Add > DiffServ Set Police

Default: None

Options: Any integer

Function: Sets the rate at which the router accepts data. Specifying the data rate can prevent the host from sending too much data to the router.

Instructions: Enter a value for the data rate.

MIB Object ID: Not applicable

Parameter: Token Bucket Size (Bits)

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Action > Add > DiffServ Set Police

Default: None

Options: Any integer

Function: Determines the burst size of the data that the router accepts. This parameter enables the router to guard against large bursts of data; it balances the flow of data.

Instructions: Enter a value for the bucket size.

MIB Object ID: Not applicable

Parameter: Min Policed (Bytes)

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Action > Add > DiffServ Set Police

Default: 20

Options: Any integer

Function: Specifies the minimum packet size that the router allows for the network. If the packet size is smaller than the value set for this parameter, the router uses this parameter value as the packet size. If the packet size is larger than this parameter, the router uses the packet's actual size.

Instructions: Enter a value for the minimum packet size that the router should police.

MIB Object ID: Not applicable

Parameter: Max Policed (Bytes)

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Action > Add > DiffServ Set Police

Default: 4294967295

Options: 0 to 4294967295

Function: Specifies the maximum packet size that the router allows for the network. This parameter lets the router prevent large packets from being admitted into the network.

Instructions: Enter a value for the maximum policed packet size. If the packet size is larger than this value, the router considers the data beyond the flow filter profile. In this case, the router refers to the Out of Profile Behavior and Out of Profile Marking parameters to determine how to treat the packet.

MIB Object ID: Not applicable

Parameter: Inprofile Marking

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Action > Add > DiffServ Set Police

Default: 00000000

Options: 00000000 to 11111100

Function: Specifies the value that the DS byte is set to if the policing algorithm accepts the packet. The value represents the type of service that the packet receives.

Instructions: Enter the value that the router should use to mark the packet.

MIB Object ID: Not applicable

Parameter: Inprofile Behavior

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Action > Add > DiffServ Set Police

Default: Mark

Options: Mark | No Change

Function: Tells the router how to treat packets that are within the filter profile.

Instructions: If you want the packet to be marked according to the value in the Inprofile Marking parameter, accept the default, Mark. If not, select No Change.

MIB Object ID: Not applicable

Parameter: Out of Profile Marking

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Action > Add > DiffServ Set Police

Default: 00000000

Options: 00000000 to 11111100

Function: If the packet size does not fit the filter profile, for example, if the host is sending more data than it should, this parameter tells the router how to mark the packet.

Instructions: Enter the value that the router should use to mark the packet.

MIB Object ID: Not applicable

Parameter: Out of Profile Behavior

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Action > Add > DiffServ Set Police

Default: No Change

Options: No Change | Mark | Drop

Function: Tells the router how to treat the packet if it does not fit the filter profile.

Instructions: If you want the packet to be marked according to the value in the Out of Profile Marking parameter, select Mark. If you want the router to drop the packet, select Drop. Otherwise, accept the default, No Change.

MIB Object ID: Not applicable

HTTP Filter Parameter

You can filter packets based on URL strings. To do this, specify the URL in the Add URL window (Figure A-11).

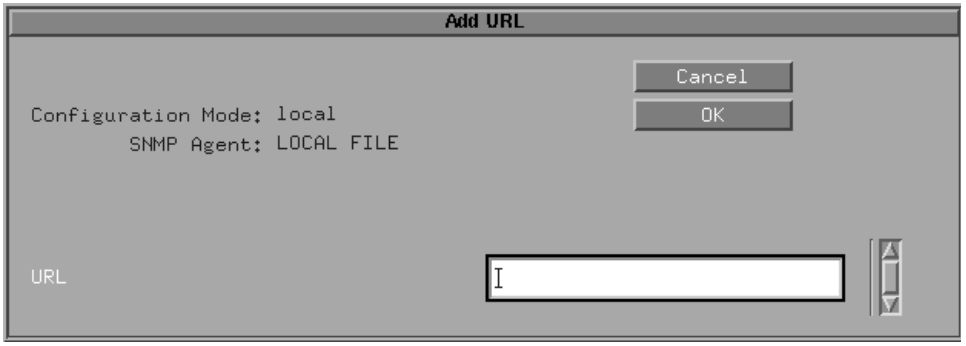


Figure A-11. Add URL Window

Parameter: URL

Path: Configuration Manager > Protocols > IP > DiffServ > Interfaces > **Traffic Filt** > **Template** > **Create** > Criteria > Add > Add URL

Default: None

Options: A URL for an HTTP host, up to a maximum of 128 characters.

Function: Specifies the URL that the router should use as a filter criterion. If the router receives a packet with this URL, the router filters the packet.

Instructions: Specify a URL for the filter, for example, www.website.com. You do not need to enter http:// before the URL; the router adds http:// automatically.

MIB Object ID: Not applicable

Appendix B
Configuration Examples

This appendix contains the following configuration examples:

Topic	Page
Differentiated Services Network Using Dynamic Filters	B-2
Differentiated Services Network Using Static Traffic Filters	B-6
Queue Management and Scheduling Configuration Example	B-11

Differentiated Services Network Using Dynamic Filters

In this configuration example, a local news station needs to download a video tape from the main news office's video server. This video contains critical pictures for a news story, so the video data needs to be given priority over other data.

Figure B-1 shows the differentiated services network.

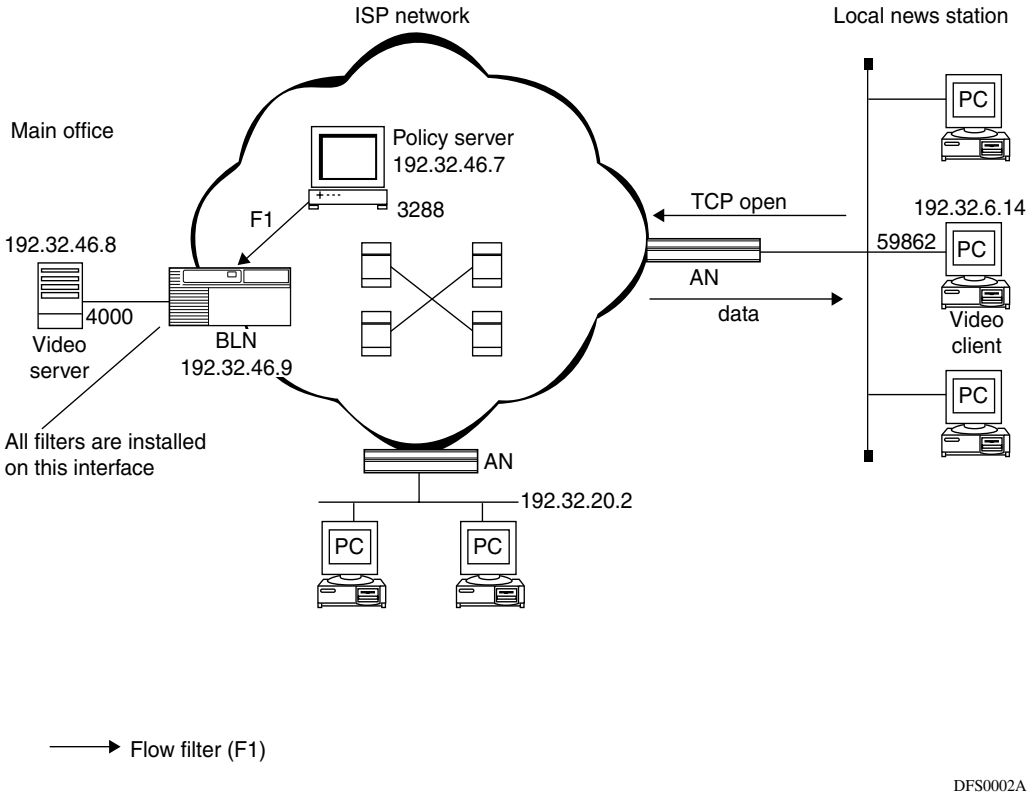


Figure B-1. Differentiated Services Network Using Dynamic Filters

Before any data can be transmitted, the system administrator for the policy server needs to create a policy. This policy generates a flow filter that the policy server installs on the BLN® router.

Table B-1 on page B-3 shows the filter installed on the BLN router.

Table B-1. Flow Filter on the BLN Router

Criteria	Flow Filter (F1)
IP source address	192.32.46.8
IP destination address	192.32.6.14
TCP source port	4000
TCP destination port	59862
Police action	2 MB/s
Idle time	2 minutes
Mark	01000000

The sequence of events in this network is as follows:

1. When the router activates, it connects to the policy server. The policy server automatically installs the flow filter (F1) on the router.
2. The remote video client establishes a TCP connection to the video server and requests the video data.
3. The video server begins sending the data to the client.
4. The router looks at each packet that it receives and marks the video packets according to the configuration of the flow filter (F1).
5. When the core devices in the network receive the marked packets, they look at the DS field, interpret the marked packet, and give the video data priority over other data, sending the data to the remote video client.
6. After all the data is sent, the BLN router waits for 2 minutes, which in this example is the idle time, and then removes the flow filter. It then sends a message to the policy server indicating that the flow filter has been removed.

Configuring the Router Using Site Manager

The router's configuration for the differentiated services network in Figure B-1 is shown in the following sections.

These tables provide instructions on how to access the appropriate Site Manager windows and configure specific parameters. Only those parameters that you must change from the default value are listed. If a parameter is not included, it means that you can accept the default value.

Configure a Differentiated Services Interface

First, configure a differentiated services interface on the BLN router and enable COPS, as follows:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, click on an IP interface connector.	The Add Circuit window opens.
2. Accept the default circuit name or enter a new name, then click on **OK**.	The Select Protocols window opens.
3. Scroll through the list of protocols and choose **DiffServ**, then click on **OK**.	The IP Configuration window opens.
4. Enter **192.32.46.9** in the **IP Address** parameter, then click on **OK**.	The DiffServ Interface List window opens. The interface is now enabled.
5. Set the **Config Type** parameter to **COPS** and click on **Apply**.	Site Manager displays a message informing you that the static filters will be deleted and asks if you want to continue.
6. Click on **OK**.	You return to the DiffServ Interface List window.
7. Go to the next section.	

Configure COPS

To enable COPS for the interface, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the DiffServ Interface List window, click on **COPS Global**.	The Edit COPS Global Parameters window opens.
2. Set the **Client IP Address** parameter to **192.32.46.9** and the **Client ID** parameter to **corp1**.	
3. Click on **OK**.	You return to the DiffServ Interface List window.
4. Click on **COPS Servers**.	The COPS Server List window opens.

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
5. Click on **Add**.	The COPS Server Record window opens.
6. Set the COPS server's **IP Address** parameter to **192.32.46.7**.	
7. Click on **OK**.	You return to the COPS Server List window. Site Manager displays the COPS server entry in the list.
8. Click on **Done**.	You return to the DiffServ Interface List.
9. Click on **Done**.	You return to the Configuration Manager window.

The router can now operate as a differentiated services edge device, marking the video data packets for priority service through the network.

Configuring the Router Using the BCC

This section provides the BCC commands that you would use to configure the BLN router shown in Figure B-1.

1. **Configure the IP interface and enable differentiated services on it by entering the following commands:**

```
box# serial 3/2
serial/3/2# ppp
ppp/3/2# ip 192.32.46.9/8
ip/192.32.46.9/255.0.0.0# diffserv
diffserv/192.32.46.9# info
    config-type static
    debug-level filter-maintenance
    state enabled
    url-idleout-timer 120
```

2. **Set the interface to use the COPS protocol:**

```
diffserv/192.32.46.9# config-type cops
```

3. **Add COPS to the router and add a COPS server:**

```
diffserv/192.32.46.9# box
box# cops address 192.32.46.9 id corp1
cops# cops-server 192.32.46.7
cops-server/192.32.46.7#
```

Differentiated Services Network Using Static Traffic Filters

In this configuration example, a corporate enterprise network connects employees to corporate information, such as benefits forms. The employees need to download forms, which are HTTP pages, from a server. When a client requests a form, this request and data should receive a higher priority than other requests, so differentiated services is implemented.

In this network, instead of using filters configured on a policy server, filters are configured statically on the router.

To implement differentiated services in this network, you must configure two interfaces on the router. One interface sends data to the clients and the other sends requests and control packets locally to the server. Two interfaces are needed because the router can implement inbound filtering only for differentiated services, which means that the router filters only packets that it receives, not those that it sends.

Figure B-2 shows the differentiated services network.

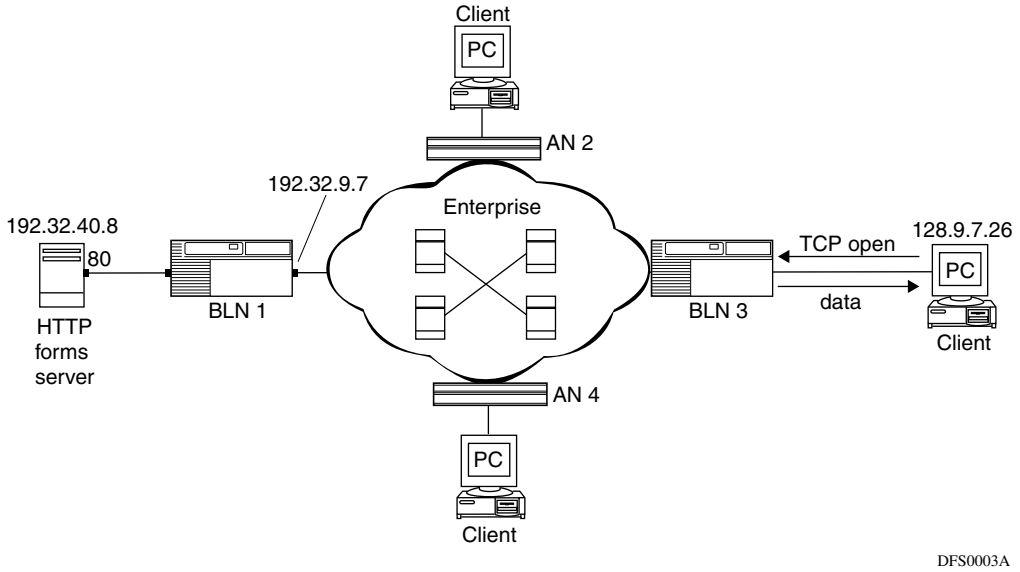


Figure B-2. Differentiated Services Network Using Static Filters

Configuring the Router Using Site Manager

For the network in Figure B-2, you must configure a static traffic filter on the router.

The tables provide instructions on how to access the appropriate Site Manager windows and configure the specific filter parameters. Only those parameters that you must change from the default value are listed. If a parameter is not included, it means that you can accept the default value.

The traffic filter that you need to configure uses the DS police action. After you configure the DS police action, the router will know how to mark packets for transmission through the network to the client.

Configure a Differentiated Services Interface

To configure a differentiated services interface on BLN 1, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, click on an IP interface connector.	The Add Circuit window opens.
2. Accept the default circuit name or enter a new name, then click on **OK**.	The Select Protocols window opens.
3. Scroll through the list of protocols and choose **DiffServ**, then click on **OK**.	The IP Configuration window opens.
4. Enter **192.32.9.7** in the **IP Address** parameter, then click on **OK**.	The DiffServ Interface List window opens. The interface is now enabled.
5. Keep the DiffServ Interface List window open and go to the next section.	

Configure a Static Filter

To configure a filter template that includes the DS police action, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the DiffServ Interface List window, select the interface that you want to modify and click on **Traffic Filt**.	The DiffServ Static Filters window opens.
2. Click on **Template**.	The Filter Template Management window opens.
3. Click on **Create**.	The Create DiffServ Template window opens.
4. Enter **httpfilter** in the **Filter Name** field.	
5. Choose **Criteria**.	The Criteria menu opens.
6. Choose **Add** and add the following criteria: • **IP Source Address**: 128.9.7.0 to 128.9.7.255 • **IP Destination Address:** 192.32.40.8 • **TCP frame** > **TCP Destination Port**: 80 • **Add URL**: URL: www.hradmin.com	
7. Choose **Action**.	The Action menu opens.
8. Choose **Add**.	The Add menu opens.
9. To filter using the DiffServ Police, choose **DiffServ Set Police** and set the following parameters: • **Token Bucket Rate (Kbps) = 5 MB/s** • **Token Bucket Size (Bits) = 1600** • **Inprofile Marking = 00100000**	
10. Click on **Save**.	You return to the Create DiffServ Template window.
11. Click on **OK.**	You return to the Filter Template Management window.
12. Click on **Done**.	You return to the DiffServ Static Filters window.

Apply the template that you just created by completing the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the DiffServ Static Filters window, click on **Create**.	The Create Filter window opens.
2. Enter **corpforms** in the **Filter Name** field.	
3. Select the differentiated services interface **192.32.9.7** in the Interfaces list.	
4. Select **httpfilter** in the Templates list.	
5. Click on **OK.**	You return to the DiffServ Static Filters window. Site Manager displays the filter name and its interface in the scroll list.
6. Click on **Done** until you return to the Configuration Manager window.	

After the router marks a packet, the packet receives preferential treatment from the core devices in the network and sends it along to the client.

Configuring the Router Using the BCC

This section provides the BCC commands that you would use to configure the BLN 1 router shown in Figure B-2.

1. **Configure the IP interface and enable differentiated services on it by entering the following commands:**

```
box# serial 3/2
serial/3/2# ppp
ppp/3/2# ip 192.32.9.7/16
ip/192.32.9.7/255.255.0.0# diffserv
diffserv/192.32.9.7#
```

2. **Create a differentiated services filter, specifying a filter name, and enter the match context for the filter:**

```
diffserv/192.32.9.7# traffic-filter filter-name httpfilter
ds-filter/httpfilter/192.32.9.7# match
match/ds-filter/httpfilter/192.32.9.7# info
   dest-tcp-ports {}
   dest-tcp-udp-ports {}
   dest-udp-ports {}
```

```
    ds-field {}
    protocol {}
    src-tcp-ports {}
    src-tcp-udp-ports {}
    src-udp-ports {}
    tcp-established off
    urls {}
```

The **info** command shows that there are no match criteria for the filter yet.

3. **Configure match criteria (rule definitions) for the IP network range of clients requesting the forms, the IP address of the HTTP forms server, and the TCP/IP port of the HTTP service on the forms server (80):**

```
match/ds-filter/httpfilter/192.32.9.7# source-network range
128.9.7.0-128.9.7.255
source-network/filter/httpfilter/192.32.9.7/128.9.7.0# back
match/ds-filter/httpfilter/192.32.9.7# destination-network 192.32.40.8
destination-network/filter/httpfilter/192.32.9.7/192.32.40.8# back
match/ds-filter/httpfilter/192.32.9.7# dest-tcp-ports 80
```

These match criteria identify the traffic to which you want to give priority, that is, the HTTP forms requests.

4. **Enter the actions context for the filter and specify police:**

```
match/ds-filter/httpfilter/192.32.9.7# actions
actions/ds-filter/httpfilter/192.32.9.7# action police
actions/ds-filter/httpfilter/192.32.9.7# info
    action police
    action-log off
    mark-value <not_set>
```

5. **Enter the police context, and specify how to police the traffic that matches the criteria so that it receives priority:**

```
actions/ds-filter/httpfilter/192.32.9.7# police
police/ds-filter/httpfilter/192.32.9.7# token-bucket-rate 5000
police/ds-filter/httpfilter/192.32.9.7# token-bucket-size 1600
police/ds-filter/httpfilter/192.32.9.7# inprofile-marking 00100000
police/ds-filter/httpfilter/192.32.9.7# info
   inprofile-behavior mark
   inprofile-marking 00100000
   max-policed 4294967295
   min-policed 20
   outprofile-behavior no-change
   outprofile-marking 00000000
   token-bucket-rate 5000
   token-bucket-size 1600
```

Queue Management and Scheduling Configuration Example

This section provides an example of how to configure all the elements necessary to set up DSQMS on a router. To implement differentiated services queue management and scheduling in this sample network, you configure two interfaces on the router:

- The Ethernet interface receives inbound data and, using a traffic filter that matches a particular source network, marks the DSCP of the packets.
- The WAN interface is configured with two DSQMS queues that sort the traffic to be forwarded.

The following sections show the commands that you would enter to create this sample configuration. The commands in this section do the following:

1. Configure an Ethernet interface for differentiated services and configure a traffic filter on that interface to mark selected incoming traffic with a DSCP.
2. Add the RED algorithm to the router and configure a dsqms-red object that contains the values for drop probability.
3. Configure a WAN (serial) interface to support two DSQMS traffic queues that each have one traffic classifier. The traffic classifiers handle outgoing traffic that is marked with a particular DSCP value (one classifier acts on the same DSCP value that is implemented using the differentiated services traffic filter configured on the Ethernet interface).

Note: For more information about configuring traffic filters, see Chapter 3, "Configuring Static Traffic Filters for Differentiated Services." For more information about any parameter shown in this section, see Chapter 6, "Customizing Queue Management and Scheduling."

Configuring a Differentiated Services Traffic Filter on an Inbound Interface

The following commands enable differentiated services on an Ethernet interface and create a traffic filter to mark the DSCP field of incoming traffic that matches the filter criteria. This traffic will be scheduled according to its DSCP field on the serial interface configured on page B-13.

```
box# eth 3/1
ethernet/3/1# ip 192.32.37.106/255.255.255.224
ip/192.32.37.106/255.255.255.224# diffserv
diffserv/192.32.37.106# traffic-filter E31_MrkGrp_1
ds-filter/E31_MrkGrp_1/192.32.37.106# match
match/ds-filter/E31_MrkGrp_1/192.32.37.106# source-network
192.32.37.101
source-network/filter/E31_MrkGrp_1/192.32.37.106/192.32.37.101#
back
match/ds-filter/E31_MrkGrp_1/192.32.37.106# back
ds-filter/E31_MrkGrp_1/192.32.37.106# actions
actions/ds-filter/E31_MrkGrp_1/192.32.37.106# info
  action accept
  action-log off
  mark-value <not_set>
actions/ds-filter/E31_MrkGrp_1/192.32.37.106# action mark
actions/ds-filter/E31_MrkGrp_1/192.32.37.106# mark-value 10101000
actions/ds-filter/E31_MrkGrp_1/192.32.37.106# info
  action mark
  action-log off
  mark-value 10101000
actions/ds-filter/E31_MrkGrp_1/192.32.37.106# box
```

Configuring RED on the Router

The following commands add RED to the router and create a set of attributes (**dsqms-red/1** object) that can be associated with traffic classifiers on an interface (this association is shown in "Configuring a Weighted Queue on an Outbound Interface" on page B-13).

```
box# red
red# dsqms-red 1
dsqms-red/1# info
  first-order-const 1
  id 1
  max-threshold 80
  min-threshold 20
  second-order-const 10
```

The **min-threshold** parameter defines the buffer percentage at which RED begins dropping packets.The **max-threshold** parameter defines the buffer percentage at which point RED drops all packets. The following commands change the default values for these parameters for dsqms-red/1.

```
dsqms-red/1# min-threshold 40    (Change min-threshold value to 40%)
dsqms-red/1# max-threshold 85     (Change max-threshold value to 85%)
dsqms-red/1# info
  first-order-const 1
  id 2
  max-threshold 85
  min-threshold 40
  second-order-const 10
dsqms-red/1# box
```

Weighted RED (WRED) is the ability to assign different drop probabilities to flows within the same queue. You could, for example, also configure dsqms-red/2 with the default **min-threshold** and **max-threshold** values (20% and 80%) and other dsqms-red objects with different values.

For RED to determine the average queue size, you also configure two parameters for the interface queues: **average-queue-gain** and **idle-queue-loss-rate**. For an example of setting these parameters to values other than the default, see page B-16.

Configuring a Weighted Queue on an Outbound Interface

The following commands create a weighted DSQMS queue on serial interface 5/1 and create a classifier for the queue. Classifiers deal with incoming traffic that has the configured DSCP values.

```
box# serial 5/1
serial/5/1# dsqms
dsqms/serial/5/1# dsqms-queue 1
dsqms-queue/1/serial/5/1# dsqms-classifier 10101000 (DSCP value set by
traffic filter on Ethernet interface)
dsqms-classifier/10101000/serial/5/1# red-id 1  (Assign the RED function
dsqms-red/1)

dsqms-classifier/10101000/serial/5/1# info
  dscp 10101000
  queue-id 1
  red-id 1 (Use the RED function with min-threshold 40%; max-threshold 85%)
```

The following commands display the default values for queue parameters.

```
dsqms-classifier/10101000/serial/5/1# back
dsqms-queue/1/serial/5/1# info
  average-queue-gain 30      (Used for RED calculation of drop probabilities)
  best-effort no (Specifies whether this queue is a best-effort queue)
  byte-limit 0   (Assign more buffers on a byte basis, used by RED)
  cfg-pkt-limit 0 (Assign more buffers on a packet basis, used by RED)
  cfg-weight 1    (Bandwidth percentage for weighted queue)
  drop-type tail-drop  (Congestion drop type: red or tail-drop)
  flow-fairness disabled    (Congestion control for multiple flows in this queue)
  id 1 (Queue ID)
  idle-queue-loss-rate 30  (Used for RED calculations of drop probabilities)
  jitter-const normal (Latency adjusted for time-sensitive packets)
  priority-level 0     (Priority level of this queue: 0 through 29)
  priority-time-quantum 100 (Priority queue bandwidth allocation)
  state disabled (Determines if this queue will be active)
  type priority  (Weighted or priority queue assignment)
```

The following commands configure the queue to be a weighted queue (the default value is to make it a priority queue) that uses the RED algorithm to drop packets when the interface is congested. You also assign a percentage of bandwidth to this queue (the **cfg-weight** parameter) and enable the queue (by default the queue is disabled when you create it). The **info** command displays the modified parameter values.

```
dsqms-queue/1/serial/5/1# type weighted  (Change from priority to weighted)
dsqms-queue/1/serial/5/1# cfg-weight 3 (Specify percentage of bandwidth)
dsqms-queue/1/serial/5/1# drop-type red  (Change the drop type to use RED)
dsqms-queue/1/serial/5/1# state enabled  (Enable the queue)

dsqms-queue/1/serial/5/1# info
  average-queue-gain 30
  best-effort no
  byte-limit 0
  cfg-pkt-limit 0
  cfg-weight 3
  drop-type red
  flow-fairness disabled
  id 1
  idle-queue-loss-rate 30
  jitter-const normal
  priority-level 0
  priority-time-quantum 100
  state enabled
  type weighted
```

When you change parameters for the **dsqms**, **dsqms-queue**, or **dsqms-classifier** objects, you must restart DSQMS on the interface for the changes to take effect.

```
dsqms-queue/1/serial/5/1# back
dsqms/serial/5/1# restart set  (Queue 1 becomes active)
```

Use the **show** commands to display configuration and statistical information about queues and interfaces. For information about all **show** commands for DSQMS, RED, and differentiated services, see Appendix C, "Using BCC show Commands."

```
dsqms/serial/5/1# sho dsqms q sum

show dsqms queues summary                  Dec 07, 2000 11:40:11 [GMT-5]

                          Best   Priority Cfg  Wgh Flow     Drop   Jitter
Cct Id State Status Type Effort Level Weight (%) Fairness  Type    Const
--- -- ----- ------ ---- ------ ----- ------ --- -------- -----  -------
S51 1  enabled active w    no    n/a    3    100 disabled  red    normal


dsqms/serial/5/1# sho dsqms q stats

show dsqms queues stats                 Dec 07, 2000 11:40:21 [GMT-5]

              Pkt      Byte     Xmit     Xmit     Dropped  Dropped
Cct      Id   Count    Count    Pkts     Bytes    Pkts     Bytes
----     ---- -------- -------- -------- -------- -------- --------
S51      1    0        0        1        76       0        0
```

Configuring a Priority Queue on the Same Outbound Interface

The following commands create a second, priority queue on serial interface 5/1 and a classifier for this queue.

```
dsqms/serial/5/1# dsqms-queue 2
dsqms-queue/2/serial/5/1# dsqms-classifier 11111100  (Packets with this DSCP field will be routed to this queue)
dsqms-classifier/11111100/serial/5/1# back
dsqms-queue/2/serial/5/1# info
  average-queue-gain 30
  best-effort no
  byte-limit 0
  cfg-pkt-limit 0
  cfg-weight 1
  drop-type tail-drop
```

```
flow-fairness disabled
id 2
idle-queue-loss-rate 30
jitter-const normal
priority-level 0
priority-time-quantum 100
state disabled
type priority
```

The following commands change the default values for the **average-queue-gain** and **idle-queue-loss-rate** parameters. The average queue gain is the percentage amount that the queue size must increase before RED computes a new average queue size (used to determine drop probability); the idle queue loss rate is the percentage amount that the queue size must decrease before RED computes a new average queue size.

You also assign a percentage of bandwidth to this queue (**priority-time-quantum** parameter) and enable the queue (by default the queue is disabled when you create it). Finally, you go back to the interface DSQMS prompt and restart DSQMS.

```
dsqms-queue/2/serial/5/1# average-queue-gain 40  (40% queue gain must occur)
dsqms-queue/2/serial/5/1# idle-queue-loss-rate 40  (40% queue reduction must occur)
dsqms-queue/2/serial/5/1# priority-time-quantum 200  (bandwidth allocation)
dsqms-queue/2/serial/5/1# state enabled (Enables queue for use)
dsqms-queue/2/serial/5/1# back
dsqms/serial/5/1# restart set
```

Use the **show dsqms queues** command to display configuration information about the two queues configured on serial interface 5/1. (For information about all **show** commands for DSQMS, RED, and differentiated services, see Appendix C, “Using BCC show Commands.”)

```
dsqms/serial/5/1# show dsqms q sum
```

```
show dsqms queues summary              Dec 07, 2000 15:42:27 [GMT-5]

                        Best   Priority Cfg    Weight Flow      Drop     Jitter
Cct Id  State Status Type Effort Level    Weight (%)    Fairness  Type     Const
--- -- ------ ------ ---- ------ -------- ------ ------ --------- -------  ------
S51  1  enabled active  w    yes    n/a      3      100 disabled  red      normal
S51  2  enabled active  p    no     0        n/a    n/a disabled  tail-dropnormal
```

Note: Compare the value of the "Best Effort" field for queue 1 with the same value on page B-15. By default, DSQMS selects the weighted queue with the lowest configured weight as the best-effort queue. For more information about how DSQMS selects the best-effort queue and how to override the default, see "Modifying a DSQMS Queue" on page 6-5.

Displaying the DSQMS Configuration Using the show Command

Use the **show config -r** command to display the configuration. To see the entire configuration of the router, go to the box or stack prompt and enter **show config -all**.

```
dsqms/serial/5/1# box
box# red
red# show config –r
red
  dsqms-red id 1
      max-threshold 85
      min-threshold 40
  back
back

red# box
box# ethernet 3/1
ethernet/3/1# show config –r
ethernet slot 3 connector 1
    circuit-name E31
  ip address 192.32.37.106 mask 255.255.255.224
    arp
    back
    diffserv
      traffic-filter filter-name E31_MrkGrp_1
        match
          source-network range 192.32.37.101
          back
        back
        actions
            action mark
            mark-value 10101000
        back
      back
    back
  back
```

```
back

ethernet/3/1# box; serial/5/1; dsqms
dsqms/serial/5/1# show config -r
dsqms
  dsqms-queue id 1
      best-effort yes
      cfg-weight 3
      drop-type red
      state enabled
      type weighted
    dsqms-classifier dscp 10101000
#       queue-id 1
        red-id 1
    back
  back
  dsqms-queue id 2
      average-queue-gain 40
      idle-queue-loss-rate 40
      priority-time-quantum 200
      state enabled
    dsqms-classifier dscp 11111100
#       queue-id 2
    back
  back
back
```

Appendix C
Using BCC show Commands

To display configuration and statistical data about differentiated services from the management information base (MIB), use the BCC **show** command.

This appendix contains descriptions of the following **show** commands:

Command	Page
show cops global	C-2
show cops servers	C-3
show diffserv global	C-3
show diffserv interfaces	C-4
show diffserv traffic-filter detail	C-5
show diffserv traffic-filter summary	C-5
show dsqms classifiers	C-6
show dsqms interfaces details	C-7
show dsqms interfaces stats	C-8
show dsqms interfaces summary	C-9
show dsqms queues detail	C-9
show dsqms queues stats	C-11
show dsqms queues summary	C-12
show dsqms red	C-13

Online Help for show Commands

To display a list of command options, enter one of these commands at any BCC prompt:

- **show cops ?**
- **show diffserv ?**
- **show dsqms ?**

To learn more about any **show** command option and its syntax, use the question mark (**?**) command as follows:

Example

```
bcc> show diffserv ?
show diffserv
   global       interfaces       traffic-filter
bcc> show diffserv traffic-filter ?
show diffserv traffic-filter
   detail summary
bcc> show diffserv traffic-filter detail ?
show diffserv traffic-filter detail [-precedence <arg>]
[-type <arg>] [-status <arg>] [-name <arg>] [-interface <arg>]
```

show cops global

The **show cops global** command displays the COPS client base record. This record shows how the router is configured as a client for COPS servers. This command takes no filter flags or filter arguments.

The output includes the following information:

State	State of the COPS client: Enabled, Disabled, or Notpresent.
Client IP Address	IP address of the router interface that serves as the COPS client.
ID	Alphanumeric string that identifies the COPS client.
Solo Slot	Slot number on which the COPS soloist can operate.
Cops is running on slots	Slot numbers on which COPS is running.

show cops servers

The **show cops servers** command displays a table of configured COPS servers or specific information based on the address filter that you use. This command allows the following command filter flag and argument:

-address *<ip_address>*	Displays information about the COPS server with the specified address.

The output includes the following information for each COPS server:

IP Address	IP address of the COPS server.
Priority	The order in which the COPS client queries the COPS servers for filter information.
Conn State	Whether the client connection to this COPS server is up or down.
Report Timer	The time between transmission of statistics reports to the server.
Keep Alive Timer	The time between transmission of keepalive packets to the server.
Retry Count	The number of connection attempts that the router makes before determining that the server is unreachable.
Conn Timer	The seconds between connection retry attempts to the server.

show diffserv global

The **show diffserv global** command displays the differentiated services base record. This command takes no filter flags or filter arguments.

The output includes the following information:

State	State of differentiated services: Enabled, Disabled, or Notpresent.
DS byte mask	The default IP packet header differentiated services code point (DSCP) that triggers differentiated services activation.

show diffserv interfaces

The **show diffserv interfaces** command displays a table of interfaces where differentiated services is configured, or specific information based on the filters that you use. This command allows the following command filter flags and arguments:

-address *<ip_address>*	Displays information about the configuration on the specified IP interface.
-circuit *<circuit_no.>*	Displays information about the configuration for the specified circuit.
-state {**enabled** | **disabled**}	Displays information about only the interfaces that are enabled or disabled, depending upon the argument provided.
-status {**up** | **down** | **notpresent**}	Displays information about only the interfaces that are up, down, or not present, depending upon the argument provided.
-type {**static** | **cops**}	Displays information about only the static or COPS interfaces, depending upon the argument provided.

The output includes the following information:

IP Address	The IP address for a particular interface.
Circuit	The circuit number of the interface.
State	State of the interface configuration: enabled or disabled.
Status	Current status of the interface: up, down, or notpresent.
Config Type	Filter type configured for the interface: static or COPS.

show diffserv traffic-filter detail

The **show diffserv traffic-filter detail** command lists filters and their configured match and action parameters. Use the **show diffserv traffic-filter summary** command along with this command to view all information about a traffic filter. This command allows the following command filter flags and arguments:

-precedence *<integer>*	Displays information about traffic filters with the specified precedence level.
-interface *<ip_address>*	Displays information about traffic filters for the specified interface.
-name *<string>*	Displays information about the traffic filter with the specified name.
-state {**enabled** | **disabled**}	Displays information about only the traffic filters that are enabled or disabled, depending upon the argument provided.
-status {**active** | **inactive**}	Displays information about only the traffic filters that are active or inactive, depending upon the argument provided.
-type {**static** | **cops**}	Displays information about only the static or COPS traffic filters, depending upon the argument provided.

The output includes the following information:

Filter	Name of the traffic filter.
Match	Match criteria configured for the filter, such as source or destination ports, DS field, or URLs.
Action	Actions taken on matching traffic, including policing parameters.

show diffserv traffic-filter summary

The **show diffserv traffic-filter summary** command displays a table of filters and their basic configured parameters. This command allows the same command filter flags and arguments as the **show diffserv traffic-filter detail** command.

The output includes the following information:

Cct	Circuit number where the traffic filter is configured.
IP Interface	IP interface where the traffic filter is configured.
Filter Name	Name of the traffic filter.
State	State of the traffic filter: enabled or disabled.
Status	Current status of the traffic filter: active or inactive.
Type	Type of traffic filter: static or COPS.
Precedence	Precedence level compared with other traffic filters on the interface; lowest number takes precedence.
Total Pkts/Bytes	Amount of traffic processed by this filter.
Oop Pkts/Bytes	Amount of traffic that was out of profile for the filter.

show dsqms classifiers

The **show dsqms classifiers** command displays a table of circuits where DSQMS classifiers are configured, or specific information based on the filter that you use. This command allows the following command filter flags and arguments:

-circuit *<circuit_no.>*	Displays information about the classifiers configured for the specified circuit.
-dscp *<octet_value>*	Displays information about the classifiers configured to handle traffic with the specified DSCP.
-queue *<queue_id>*	Lists the DSQMS classifiers associated with the specified queue.
-red *<red_id>*	Lists the DSQMS classifiers that use the RED instance specified by the RED identification number.

The output includes the following information:

Circuit	Name of the circuit with the specified classifier.
DSCP	Differentiated services code point in the packet header that traffic must match to be handled by the classifier.
Queue Id	DSQMS queue that the classifier is associated with.
Red Id	The RED function instance that the classifier applies to matching traffic.

For example, the following **show dsqms classifiers** command displays classifier information for three circuits, S21, S23, and S24:

```
dsqms/serial/3/3# show dsqms classifiers

Circuit          DSCP             Queue Id         Red Id
-----------------------------------------------------------------
S21              11110000         1                1
S21              11100000         2                2
S23              11110000         1                3
S24              11100000         2                3
```

Classifiers for circuits S21 and S23 handle traffic with the same DSCP, but this kind of traffic on circuit S21 is handled by a different RED configuration than this kind of traffic arriving on circuit S23.

Circuits S23 and S24 both use RED configuration number 3 for certain traffic that arrives on their interfaces, but each circuit uses it for different kinds of traffic, as specified by the different DSCPs. For an illustration of the relationship between classifiers, queues, and RED configurations, see Figure 2-2 on page 2-8.

show dsqms interfaces details

The **show dsqms interfaces details** command lists interfaces (circuits) where DSQMS is configured, or specific information based on the filter that you use. This command allows the following command filter flags and arguments:

-circuit <*circuit_no.*>	Displays information about the specified interface only.
-state {**enabled** | **disabled**}	Displays information about only the interfaces where DSQMS is either enabled or disabled, depending upon the argument provided.
-status {**active** | **inactive** | **notpresent**}	Displays information about only the interfaces where DSQMS is active, inactive, or not present, depending upon the argument provided.

The output includes the following information:

Circuit	Name of the interface.
State	State of DSQMS on the interface: enabled or disabled.
Status	Current status of DSQMS: active, inactive, or not present.

Total Queues	Number of DSQMS queues configured on the interface.
Cfg PQueues	Number of priority queues configured.
Cfg WQueues	Number of weighted queues configured.
PQueues In Use	Number of priority queues in use.
WQueues In Use	Number of weighted queues in use.
Debug Level	Current setting for entering debug messages in the event log.
Best-effort Queue Id	Queue on the interface that is used for best-effort traffic.
Pkt Count	Number of packets queued.
Byte Count	Number of octets queued.
Xmit Pkts	Number of packets transmitted.
Xmit Bytes	Number of octets transmitted.
Dropped Pkts	Number of dropped packets.
Dropped Bytes	Number of dropped octets.

show dsqms interfaces stats

The **show dsqms interfaces stats** command displays a table of interfaces where DSQMS is configured, or information on a specific interface if you use the filter flag, with a subset of the information from the **show dsqms interfaces details** command. This command allows the following command filter flag and argument:

-circuit *<circuit_no.>*	Displays information about the specified circuit only.

The output includes the following information:

Cct	Name of the circuit.
Pkt Count	Number of packets queued.
Byte Count	Number of octets queued.
Xmit Pkts	Number of packets transmitted.
Xmit Bytes	Number of octets transmitted.
Dropped Pkts	Number of dropped packets.
Dropped Bytes	Number of dropped octets.

show dsqms interfaces summary

The **show dsqms interfaces summary** command displays a table of interfaces where DSQMS is configured, or specific information based on the filter that you use, with a subset of the information from the **show dsqms interfaces details** command. This command allows the following command filter flags and arguments:

-circuit *<circuit_no.>*	Displays information about the specified interface only.
-state {**enabled** | **disabled**}	Displays information about only the interfaces where DSQMS is either enabled or disabled, depending upon the argument provided.
-status {**active** | **inactive** | **notpresent**}	Displays information about only the interfaces where DSQMS is active, inactive, or not present, depending upon the argument provided.

The output includes the following information:

Cct	Name of the interface.
State	State of DSQMS on the interface: enabled or disabled.
Status	Current status of DSQMS: active, inactive, or not present.
Best-effort Queue Id	Queue on the interface that is used for best-effort traffic.
Priority Queues	Number of priority queues configured.
Weighted Queues	Number of weighted queues configured.

show dsqms queues detail

The **show dsqms queues detail** command lists all DSQMS queues, or specific information based on the filter flags that you use. This command allows the following command filter flags and arguments:

-besteffort {**yes** | **no**}	Displays information about only best-effort queues or only non-best-effort queues, depending upon the argument provided.
-circuit *<circuit_no.>*	Displays information about queues on the specified circuit only.

-droptype *<type>*	Displays information about queues with the specified drop type only.
-flowfairness {**enabled** | **disabled**}	Displays information about only queues with flow fairness enabled or only queues with flow fairness disabled, depending upon the argument provided.
-id *<id_number>*	Displays information about queues with the specified identification. Queues on different interfaces may have the same identification.
-state {**enabled** | **disabled**}	Displays information about only the queues that are enabled or disabled, depending upon the argument provided.
-status {**active** | **inactive** | **notpresent**}	Displays information about only queues that are active, inactive, or not present, depending upon the argument provided.
-type {**priority** | **weighted**}	Displays information about only priority or weighted queues, depending upon the argument provided.

The output includes the following information:

Circuit	Name of the interface.
Id	Identification number of the queue.
State	State of the DSQMS queue: enabled or disabled.
Status	Status of the queue: active, inactive, or not present.
Type	Type of queue: priority or weighted.
Best Effort	Does queue handle best-effort traffic for the interface: yes or no.
Priority Level	Priority number assigned to the queue.
Priority Quantum	Amount of time that this priority queue is allowed to transmit traffic during round-robin queue servicing.
Pkt Limit	Maximum number of packets this queue can hold.
Byte Limit	Maximum number of bytes this queue can hold.
Cfg Weight	Configured percentage of traffic for a weighted queue.
Actual Weight (%)	Actual percentage of traffic for a weighted queue. If the configured weight percentages add up to more than 100%, actual weights are calculated proportionally.
Quantum (bytes)	Number of bytes this queue is allowed to transmit for each dequeue.
Flow Fairness	Status of flow fairness: enabled or disabled.

Jitter Const	Sensitivity to the jitter effect: small, normal, or large.
Bucket Quantum	Number of bytes that the flow-fairness bucket is allowed to transmit for each dequeue.
Drop Type	How packets are dropped: using RED or simple tail-drop.
Pkt Count	Number of packets queued.
Byte Count	Number of octets queued.
Xmit Pkts	Number of packets transmitted.
Xmit Bytes	Number of octets transmitted.
Dropped Pkts	Number of dropped packets.
Dropped Bytes	Number of dropped octets.
Average Queue Gain	Percentage of buffer capacity that must fill for 1 second or more for DSQMS to compute a larger average queue size for use by RED.
Idle Queue Loss Rate(%)	Percentage of buffer capacity that must empty for 1 second or more for DSQMS to compute a smaller average queue size for use by RED.

show dsqms queues stats

The **show dsqms queues stats** command displays a table of DSQMS queues, or specific information based on the filter argument that you use, with a subset of the information from the **show dsqms queues detail** command. This command allows the following command filter flag and argument:

-circuit *<circuit_no.>*	Displays information about queues on the specified circuit only.

The output includes the following information:

Cct	Name of the circuit.
Id	Identification number of the queue.
Pkt Count	Number of packets queued.
Byte Count	Number of octets queued.
Xmit Pkts	Number of packets transmitted.
Xmit Bytes	Number of octets transmitted.

Dropped Pkts	Number of dropped packets.
Dropped Bytes	Number of dropped octets.

show dsqms queues summary

The **show dsqms queues summary** command displays a table of interfaces where DSQMS is configured, or specific information based on the filter flags that you use, with a subset of the information from the **show dsqms queues detail** command. This command allows the following command filter flags and arguments:

-besteffort {**yes** | **no**}	Displays information about only best-effort queues or only non-best-effort queues, depending upon the argument provided.
-circuit *<circuit_no.>*	Displays information about queues on the specified circuit only.
-droptype *<type>*	Displays information about queues with the specified drop type only.
-flowfairness {**enabled** | **disabled**}	Displays information about only queues with flow fairness enabled or only queues with flow fairness disabled, depending upon the argument provided.
-id *<id_number>*	Displays information about queues with the specified identification. Queues on different interfaces may have the same identification.
-state {**enabled** | **disabled**}	Displays information about only the queues that are enabled or disabled, depending upon the argument provided.
-status {**active** | **inactive** | **notpresent**}	Displays information about only queues that are active, inactive, or not present, depending upon the argument provided.
-type {**priority** | **weighted**}	Displays information about only priority or weighted queues, depending upon the argument provided.

The output includes the following information:

Cct	Name of the circuit.
Id	Identification number of the queue.
State	State of the DSQMS queue: enabled or disabled.
Status	Status of the queue: active, inactive, or not present.
Type	Type of queue: priority or weighted.
Best Effort	Does queue handle best-effort traffic for the interface: yes or no.
Priority Level	Priority number assigned to the queue.
Cfg Weight	Configured percentage of traffic for a weighted queue.
Weight (%)	Actual percentage of traffic for a weighted queue. If configured weight percentages add up to more than 100%, actual weights are calculated proportionally.
Flow Fairness	Status of flow fairness: enabled or disabled.
Drop Type	How packets are dropped: using RED or simple tail-drop.
Jitter Const	Sensitivity to the jitter effect: small, normal, or large.

show dsqms red

The **show dsqms red** command displays a table of configured RED instances. This command takes no filter flags or filter arguments.

The output includes the following information:

ID	Number of the RED instance.
Status	Status of the RED instance.
2nd Order Const	Second order constant used when calculating drop probability.
1st Order Const	First order constant used when calculating drop probability.
Min Threshold (%)	Queue size below which no packets are dropped by RED.
Max Threshold (%)	Queue size above which all packets are dropped by RED.

Index

A

acronyms, xviii

actions for static filters
- described, 3-2, 3-4
- log, 3-15
- mark, 3-13
- police, 3-14
- specifying, 3-13

average-queue-gain, QMS, 6-5

B

best-effort, QMS, 6-5

byte-limit, QMS, 6-5

C

cfg-pkt-limit, QMS, 6-5

cfg-weight, QMS, 6-5

classifiers
- changing RED functions, 6-8
- configuring, 2-12
- description, 2-8

Client ID parameter, A-8

Client IP Address parameter, A-8

Common Open Policy Service. *See* COPS

Config Type parameter, A-4

configuration examples, B-1

Connection Retry Count parameter, A-11

Connection Retry Period parameter, A-10

connection-timer, COPS, 5-5

conventions, text, xvi

COPS
- adding servers, 5-3
- connecting to a server, 5-5
- connection with policy server, 1-4
- connection-timer, 5-5
- deleting from the router, 5-13
- deleting servers, 5-11
- disabling, 5-12
- disabling servers, 5-10
- enabling using Site Manager, 2-6
- enabling using the BCC, 2-4
- global parameters, modifying, 5-2, A-7
- keepalive-timer, 5-5
- prioritizing servers, 5-4
- priority parameter, 5-5
- remote-port, 5-5
- report-timer, 5-5
- retry-counter, 5-5
- server records
  - modifying, 5-4
  - parameters, A-15
- tcp-keepalive-max-retry, 5-6
- tcp-keepalive-timer, 5-6
- tcp-rto, 5-6

core network device, description, 1-3

criteria for static filters, 3-2, 3-4

customer support, xix

D

debug level for QMS, 6-4

Debug Log Mask parameter, A-3

default configuration, starting, 2-1

deficit round robin (DRR), QMS, description, 1-10

deleting
COPS from the router, 5-13
COPS server, 5-11
differentiated services interface, 4-6, 4-7
unused DSQMS RED entries, 6-9
differentiated services
configuration examples, B-1
description, 1-1
enabling using Site Manager, 2-5
enabling using the BCC, 2-3
interfaces
deleting, 4-6
disabling, 4-4, 4-5
modifying, 4-2
methods for installing filters, 1-1
network devices, 1-2
network planning, 2-2
starting a default configuration, 2-1
starting using Site Manager, 2-5
starting using the BCC, 2-3
differentiated services code point. *See* DSCP
drop-type, QMS, 6-5
DRR (deficit round robin), QMS, description, 1-10
DS field
configuration, 3-21, A-18
description, 1-1
marking by filters, 1-6
match criterion, 3-10
DS police, configuration, 3-21, A-19
DSCP
described, 2-8
match criterion, 3-10
dynamic filter, description, 1-8

E

edge router, description, 1-3
Enable parameter
COPS, A-7, A-10
global, A-6
interface, A-3

F

filters
COPS
enabling using Site Manager, 2-6
enabling using the BCC, 2-4
installation, 1-5
filter IDs, 1-4
methods for installing, 1-1
static
action description, 3-2, 3-4
action specification, 3-13
configuration example, B-6
configuring, 3-1
creating using Site Manager, 3-19
creating using the BCC, 3-5
criteria description, 3-2, 3-4
description, 3-2
disabling, 3-16
enabling using Site Manager, 3-19
enabling using the BCC, 3-16
match criteria, 3-6
precedence description, 3-3
precedence usage, 3-5
range description, 3-2
templates, 3-2, 3-17
terminology, 3-1
types, 2-4, 2-5
URL, 3-20, 3-22
flow filter
definition, 1-2
installation, 1-5
flow-fairness, QMS, 6-5

H

HTTP filters. *See* URL filters

I

idle-queue-loss-rate, QMS, 6-5
Inprofile Behavior parameter, A-22
Inprofile Marking parameter, A-21
interface parameters, A-2

interfaces
deleting using Site Manager, 4-7
deleting using the BCC, 4-6
disabling using Site Manager, 4-5
disabling using the BCC, 4-4
enabling using Site Manager, 2-5
enabling using the BCC, 2-3
modifying, 4-2
IP Address parameter
COPS server, A-16
diffserv global, A-5

J

jitter-const, QMS, 6-5

K

KeepAlive Time Period parameter, A-11
keepalive-timer, COPS, 5-5

L

log action for static filters, 3-15

M

mark action for static filters, 3-13
match criteria
destination network, 3-6
DS field, 3-10
protocol identifiers, 3-9
source network, 3-6
specifying, 3-6
TCP and UDP ports, 3-7
TCP-established, 3-11
URL, 3-11
user-defined, 3-12
Max Policed (bytes) parameter, A-21
Min Policed (bytes) parameter, A-20

N

next-hop interfaces, configuration, 1-8

O

OPS
connection to router, 1-4
filter action requests, 1-4
filter IDs, 1-4
installing filters, 1-2
See also policy server
Optivity policy server. *See* OPS
Out of Profile Behavior parameter, A-22
Out of Profile Marking parameter, A-22

P

packets, marking for services, 1-5
police action for static filters, 3-14
policy server
configuration example, B-2, B-11
description, 1-2
filter action requests, 1-4
filter IDs, 1-4
precedence for static filters
described, 3-3
usage, 3-5
Priority parameter, 5-5, A-10
priority queues, time-quantum, 1-10
priority-level, QMS, 6-6
priority-time-quantum, QMS, 6-6
product support, xix
protocol identifiers, filter match criteria, 3-9
publications, hard copy, xix

Q

QMS
activating changes, 6-3
average-queue-gain, 6-5
best-effort, 6-5
byte-limit, 6-5
cfg-pkt-limit, 6-5
cfg-weight, 6-5

QMS *(continued)*
classifiers
changing RED functions, 6-8
configuring, 2-12
description, 2-8
configuring, 2-7
configuring queues, 2-12
customizing, 6-1
customizing RED, 6-2
debug level, 6-4
description, 1-9
disabling, 6-8
drop-type, 6-5
enabling, 2-11
flow-fairness, 6-5
idle-queue-loss-rate, 6-5
jitter-const, 6-5
priority-level, 6-6
priority-time-quantum, 6-6
queue customization, 6-5
restarting, 6-3
type of queue, 6-6
queue management and scheduling. *See* QMS
queue quantum, description, 1-10
queue type, QMS, 6-6

R

Random Early Detection. *See* RED
ranges for static filters, 3-2
RED
configuring, 2-10
customizing, 6-2
deleting configurations, 6-9
deleting globally, 6-9
description, 1-9, 2-7
enabling, 2-10
Remote TCP Port parameter, A-14
remote-port, COPS, 5-5
Report Time Period parameter, A-12
report-timer, COPS, 5-5
retry-counter, COPS, 5-5
RFC 2474, A-18

S

server manager, description, 1-3
servers, COPS
adding, 5-3
deleting, 5-11
disabling, 5-10
prioritizing, 5-4
show commands, C-1
Site Manager
enabling differentiated services, 2-5
parameter descriptions, A-1
starting, 2-2
Solo Slot Mask parameter, A-8
static filters
action description, 3-2, 3-4
actions, specifying, 3-13
configuration example, B-6
configuring, 3-1
creating using Site Manager, 3-19
creating using the BCC, 3-5
criteria description, 3-2, 3-4
description, 3-2
disabling, 3-16
enabling using Site Manager, 3-19
enabling using the BCC, 3-16
log action, 3-15
mark action, 3-13
match criteria, 3-6
police action, 3-14
precedence
description, 3-3
usage, 3-5
range description, 3-2
templates, 3-2, 3-17
terminology, 3-1
URL criteria, 3-20, 3-22
support, Nortel Networks, xix

T

TCP
changing the port for COPS server, 5-9
configuring the connection to COPS server, 5-7
match ports criteria for static filters, 3-7

TCP *(continued)*
match TCP-established criterion for static filters, 3-11
response to WRED queue management, 1-9
TCP KeepAlive Interval parameter, 5-6, A-12
TCP KeepAlive Max Retry Cnt parameter, 5-6, A-13
TCP KeepAlive RTO parameter, 5-6, A-13
technical publications, xix
technical support, xix
templates, filter, description, 3-2
text conventions, xvi
time-quantum, description, 1-10
Token Bucket Rate (Kbps) parameter, A-20
Token Bucket Size (Bits) parameter, A-20
type parameter, QMS, 6-6

U

UDP, match ports criteria for static filters, 3-7
URL filters
described, 1-8
match criterion, 3-11, 3-20
modifying, 3-22
URL Idle Out Timer parameter, A-4
usage, 1-8
URL parameter, A-23

W

weighted queues, queue quantum, 1-10
WRED (Weighted Random Early Detection),
description, 1-9